



Massachusetts  
Department of  
Transportation

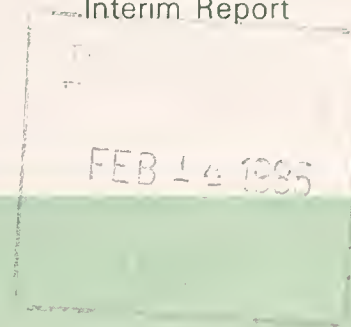
Urban Mass  
Transportation  
Administration

# Development of an Automated Emergency Response System (AERS) for Rail Transit Systems

Transportation Systems Center  
Cambridge MA 02142

October 1984

Interim Report



UMTA Technical Assistance Program

#### NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

#### NOTICE

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

HE  
18.5  
A37  
NG.  
DOT-  
TSC-  
UMTA-  
84-27

1. Report No. UMTA-MA-06-0152-84-4		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle ✓ DEVELOPMENT OF AN AUTOMATED EMERGENCY RESPONSE SYSTEM (AERS) FOR RAIL TRANSIT SYSTEMS				5. Report Date October 1984	
				6. Performing Organization Code DTS-65	
				8. Performing Organization Report No. DOT-TSC-UMTA-84-27	
7. Author(s) Joseph F. Petrie, William T. Hathaway				10. Work Unit No. (TRAIS) UM478/R4607	
9. Performing Organization Name and Address U.S. Department of Transportation Research and Special Programs Administration Transportation Systems Center Cambridge MA 02142				11. Contract or Grant No.	
				13. Type of Report and Period Covered Interim Report July 1982 - December 1983	
12. Sponsoring Agency Name and Address U.S. Department of Transportation Urban Mass Transportation Administration Office of Technical Assistance Washington DC 20590				14. Sponsoring Agency Code URT-6	
15. Supplementary Notes					
16. Abstract  This report describes the efforts of the Urban Mass Transportation Administration's (UMTA) Office of Technical Assistance, Safety and Security Staff, to evaluate the Bay Area Rapid Transit District's (BART) microprocessor-based Automated Emergency Response System (AERS) in central control rooms of other rail rapid transit systems. The report discusses the deployment of demonstration AERS systems at the Washington Metropolitan Area Transit Authority (WMATA) and at the Port Authority Transit Corporation (PATCO) of Pennsylvania and New Jersey. Also discussed are the subsequent efforts by the central control supervisory staffs through September 1983 to extend the demonstration systems into operating systems that meet not only the emergency action requirements of the respective transit systems, but other unique requirements as well.					
17. Key Words Automated Emergency Response System; BART; WMATA; PATCO; Rail Rapid Transit System Control Room; Rail Rapid Transit System Safety; Microprocessor; Demonstration Software; Emergency Action Requirements			18. Distribution Statement  DOCUMENT IS AVAILABLE TO THE PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161		
19. Security Classif. (of this report) UNCLASSIFIED		20. Security Classif. (of this page) UNCLASSIFIED		21. No. of Pages 68	
				22. Price	



# METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures				Approximate Conversions from Metric Measures			
Symbol	When You Know	Multiply by	To Find	Symbol	When You Know	Multiply by	To Find
<b>LENGTH</b>				<b>LENGTH</b>			
in	Inches	2.5	centimeters	mm	millimeters	0.04	Inches
ft	feet	30	centimeters	cm	centimeters	0.4	Inches
yd	yards	0.9	meters	m	meters	3.3	feet
mi	miles	1.6	kilometers	km	kilometers	1.1	yards
						0.6	miles
<b>AREA</b>				<b>AREA</b>			
in <sup>2</sup>	square inches	6.5	square centimeters	cm <sup>2</sup>	square centimeters	0.16	square inches
ft <sup>2</sup>	square feet	0.09	square meters	m <sup>2</sup>	square meters	1.2	square yards
yd <sup>2</sup>	square yards	0.8	square meters	km <sup>2</sup>	square kilometers	0.4	square miles
mi <sup>2</sup>	square miles	2.6	square kilometers	ha	hectares	2.5	acres
	acres	0.4	hectares				
<b>MASS (weight)</b>				<b>MASS (weight)</b>			
oz	ounces	28	grams	g	grams	0.035	ounces
lb	pounds	0.45	kilograms	kg	kilograms	2.2	pounds
	short tons (2000 lb)	0.9	tonnes	t	tonnes (1000 kg)	1.1	short tons
<b>VOLUME</b>				<b>VOLUME</b>			
tsp	teaspoons	5	milliliters	ml	milliliters	0.03	fluid ounces
Tbsp	tablespoons	15	milliliters	l	liters	2.1	pints
fl oz	fluid ounces	30	milliliters	l	liters	1.06	quarts
c	cups	0.24	liters	l	liters	0.26	gallons
pt	pints	0.47	liters	m <sup>3</sup>	cubic meters	36	cubic feet
qt	quarts	0.95	liters	m <sup>3</sup>	cubic meters	1.3	cubic yards
gal	gallons	3.8	liters				
ft <sup>3</sup>	cubic feet	0.03	cubic meters				
yd <sup>3</sup>	cubic yards	0.76	cubic meters				
<b>TEMPERATURE (exact)</b>				<b>TEMPERATURE (exact)</b>			
oF	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	oC	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature

1 in. = 2.54 cm (exactly). For other exact conversions and more detail tables see NBS MISC. Publ. 286, Units of Weight and Measures. Price \$2.25 SD Catalog No. C13 10 286.

## PREFACE

In 1979, the Bay Area Rapid Transit District (BART) had a serious fire in their Transbay Tube running under San Francisco Bay between Oakland and San Francisco. As a result of the fire, BART developed a microprocessor-based information retrieval system to aid in the emergency decision-making process. This system was proposed, designed and programmed by Richard Blake, a supervisory controller at BART.

In 1982, the Urban Mass Transportation Administration (UMTA) Office of Technical Assistance initiated an effort to encourage the installation of similar systems, referred to as Automated Emergency Response Systems (AERS), at other transit sites. The Transportation Systems Center (TSC), in support of the UMTA Safety and Security Staff, demonstrated the system to transit officials at workshops and on-site at several transit systems. Interest was generated, and two deployment sites - the Washington Metropolitan Area Transit Authority (WMATA) and the Port Authority Transit Corporation (PATCO) of Pennsylvania and New Jersey - were selected. Demonstration software was prepared for the two transit systems.

This report describes the status of the AERS and highlights the changes made by WMATA and PATCO train controllers, who have since incorporated and expanded the AERS into the operating systems of their respective central controls. It is especially significant to note that at both demonstration sites the programs were modified by central control supervisory staff who had never been trained to program in the BASIC programming language.

Among those people who have made contributions to the demonstration effort, special thanks must go to Lloyd Murphy of UMTA's Office of Safety and Security for overall guidance and the necessary funding, without which the sharing of BART's AERS with other transit systems would have been extremely difficult. Richard Blake of BART deserves special thanks for his willingness to share his original program and his time by adapting the software for WMATA and PATCO. Credit must also be given to central control superintendents Joseph Taylor, Joseph Amado and P.T. Hobgood of WMATA, and Bart Kane and William Thorpe of PATCO, for their help in deploying and expanding the AERS at their respective transit systems. Ralph Weule and William Fleisher of BART, Richard Labonski of

WMATA, David Andrus of PATCO and Donald Dzinski of APTA deserve recognition for their support and encouragement all through the deployment efforts. Special thanks also go to David Heimann of TSC and Thomas Lindsley of Dynatrend Inc. for their assistance in support of the WMATA and PATCO staffs. Mr. Heimann and Robert Dorer, also of TSC, were instrumental in preparing portions of section 7.

## TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1. INTRODUCTION	1
2. DEFINITION OF AERS	3
2.1 Data Base	3
2.2 Hardware	5
3. BART AERS	7
3.1 Microprocessor Selection	8
3.2 BART AERS Software Introductory Notes	8
3.3 Software to Retrieve Data on a Location (Function 2)	9
3.4 Software to Display Data Base Entries (Function 3)	10
3.5 BART AERS - Emergency Action Software for the Berkeley Hills Tunnel (Function 1)	10
3.6 BART AERS - Emergency Action for Software for Transbay Tube (Function 1)	13
3.7 Programs to Maintain the Files	15
3.8 Other Features in the BART Software	15
3.9 Summary	16
4. DEVELOPMENT AND DEPLOYMENT OF THE WMATA AERS DEMONSTRATION SYSTEM	23
4.1 Deployment Activities	23
4.2 WMATA AERS Demonstration Software - Information on a Location (Function 2)	24
4.3 WMATA AERS Demonstration Software - Displaying Data Base Entries (Function 3)	24
4.4 WMATA AERS Demonstration System - Programs to Update a File (Function 4)	24
4.5 WMATA AERS Demonstration System - Emergency Action Data (Function 1)	25
4.6 Additional Requirements Identified During the Installation of the Demonstration AERS	25
4.7 Identification of Additional Requirements and Priority Setting	28
4.8 Summary	29



## TABLE OF CONTENTS (Cont.)

<u>Section</u>		<u>Page</u>
5.	DEVELOPMENT AND DEPLOYMENT OF THE PATCO AERS DEMONSTRATION SYSTEM	35
5.1	Deployment Activities	35
5.2	PATCO AERS Demonstration Software - Main Menu	36
5.3	PATCO AERS Demonstration Software - Data on a Location (Function 1)	36
5.4	PATCO AERS Demonstration Software - Display Data Base Entries (Function 2)	36
5.5	Data Base Update Process (Function 5)	36
5.6	Additional Requirements	37
5.7	Summary	38
6.	CURRENT STATUS OF THE DEMONSTRATION AERS	41
6.1	WMATA	41
6.2	PATCO	42
6.3	Future Directions	43
7.	DEVELOPMENT OF A GENERALIZED, GENERIC SYSTEM	49
7.1	WMATA and PATCO Experience with the Existing Software	49
7.2	UMTA Technical Assistance to Develop the Next Generation	51



## LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
2-1	AERS SCHEMA	4
3-1	BART MAIN MENU	17
3-2	DATA RETRIEVAL ON A LOCATION (FUNCTION 2)	17
3-3	DATA RETRIEVAL ON A LOCATION (FUNCTION 2); RETRIEVAL FOR 5.5 MILEPOST ON THE C-LINE	17
3-4	RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3)	17
3-5	SUBORDINATE MENU FOR RETRIEVING DATA BASE ENTRIES (FUNCTION 3)	18
3-6	RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE TRANSITIONS	18
3-7	RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), SCREEN 2 OF C-LINE TRANSITIONS	18
3-8	RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE ACCESS POINTS	18
3-9	RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE FIRE DEPARTMENTS	19
3-10	RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE STREETS	19
3-11	RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE FANS	19
3-12	RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE THIRD RAILS - TRACK 1	19
3-13	RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE THIRD RAILS - TRACK 2	20
3-14	RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE INTERFACES	20
3-15	EMERGENCY ACTION SOFTWARE (FUNCTION 1), FIRST USER ENTRY	20
3-16	EMERGENCY ACTION SOFTWARE FOR THE BERKELEY HILLS TUNNEL, SECOND USER ENTRY	20

## LIST OF FIGURES (Cont.)

<u>Figure</u>		<u>Page</u>
3-17	EMERGENCY ACTION SOFTWARE FOR THE BERKELEY HILLS TUNNEL, THIRD USER ENTRY	21
3-18	EMERGENCY ACTION SOFTWARE FOR THE BERKELEY HILLS TUNNEL, PROGRAM EXECUTION DISPLAY	21
3-19	EMERGENCY ACTION SOFTWARE FOR THE BERKELEY HILLS TUNNEL, RESULTING DISPLAY	21
3-20	EMERGENCY ACTION SOFTWARE, C-LINE LOCATION NOT COVERED BY BHT PROGRAM	21
3-21	TUBE AND TUNNEL EMERGENCY INSTRUCTIONS	22
3-22	EMERGENCY ACTION SOFTWARE, TRANSBAY TUBE	22
3-23	BART FILE MAINTENANCE MENU	22
3-24	LISTING OF SELECTED FILES MAINTAINED USING UPDATE PROGRAM FOR BART	22
4-1	WMATA MAIN MENU	30
4-2	WMATA DEMONSTRATION AERS, DISPLAY INFORMATION ON A LOCATION (FUNCTION 2), FIRST SCREEN	30
4-3	DATA RETRIEVAL ON LOCATION (FUNCTION 2) INPUT FOR K-LINE CHAIN MARKER 25000	30
4-4	DATA RETRIEVAL ON A LOCATION (FUNCTION 2) INPUT, STATION CODE	30
4-5	DATA RETRIEVAL ON A LOCATION (FUNCTION 2) INPUT, TWO STATION CODES	31
4-6	DISPLAY DATA BASE ENTRIES (FUNCTION 3), FIRST SCREEN	31
4-7	DISPLAY DATA BASE ENTRIES (FUNCTION 3), C-LINE ACCESS POINTS	31
4-8	DISPLAY DATA BASE ENTRIES (FUNCTION 3), C-LINE STREETS	31
4-9	DISPLAY DATA BASE ENTRIES (FUNCTION 3), C-LINE THIRD RAIL TRACK NO. 1	32

## LIST OF FIGURES (Cont.)

<u>Figure</u>		<u>Page</u>
4-10	DISPLAY DATA BASE ENTRIES (FUNCTION 3), C-LINE THIRD RAIL TRACK NO. 2	32
4-11	DISPLAY DATA BASE ENTRIES (FUNCTION 3), C-LINE FIRE DEPARTMENTS	32
4-12	FILE MAINTENANCE SOFTWARE (FUNCTION 4), FIRST SCREEN	32
4-13	FILE MAINTENANCE SOFTWARE (FUNCTION 4), SECOND SCREEN	33
4-14	FILE MAINTENANCE SOFTWARE (FUNCTION 4), SEARCHING A FILE	33
4-15	FILE MAINTENANCE SOFTWARE (FUNCTION 4), SEARCHING A FILE BY RETRIEVING AN ITEM	33
4-16	EMERGENCY ACTION DATA (FUNCTION 1), FIRST SCREEN	33
4-17	EMERGENCY ACTION DATA (FUNCTION 1), SECOND SCREEN	34
4-18	EMERGENCY ACTION DATA (FUNCTION 1): C-LINE, CHAIN MARKER 3500, 6-CAR TRAIN, FIRE LOCATION IN FRONT	34
4-19	RETRIEVAL OF EMERGENCY ACTION DATA (FUNCTION 1) BY STATION CODE	34
4-20	RETRIEVAL OF EMERGENCY ACTION DATA (FUNCTION 1) BY LINE AND CHAIN MARKER	34
5-1	PATCO DEMONSTRATION AERS, MAIN MENU	39
5-2	DISPLAY DATA ON A LOCATION (FUNCTION 1), FIRST SCREEN	39
5-3	DISPLAY DATA ON A LOCATION (FUNCTION 1), SECOND SCREEN	39
5-4	PATCO DEMONSTRATION AERS, DISPLAY DATA BASE ENTRIES (FUNCTION 2) FOR THIRD RAIL, TRACK NO. 2	39
5-5	PATCO DEMONSTRATION AERS, DISPLAY DATA BASE ENTRIES (FUNCTION 2) FOR INTERLOCKINGS	40
5-6	PATCO DATA BASE UPDATE PROGRAM (FUNCTION 5), FIRST SCREEN	40

## LIST OF FIGURES (Cont.)

<u>Figure</u>		<u>Page</u>
5-7	PATCO DATA BASE UPDATE (FUNCTION 5) SEARCH ROUTINE	40
5-8	PATCO DATA BASE UPDATE (FUNCTION 5) SEARCH ROUTINE FOR AN ITEM TEXT RETRIEVAL	40
6-1	WMATA SYSTEM MAP	44
6-2	WMATA EMERGENCY PROCEDURES CHECKLIST, MAIN MENU	44
6-3	WMATA EMERGENCY PROCEDURES CHECKLIST, FIRST OPTION	44
6-4	WMATA EMERGENCY PROCEDURES CHECKLIST, TRAIN FIRE OPTION	44
6-5	WMATA EMERGENCY PROCEDURES CHECKLIST, STATION FIRE OPTION	45
6-6	WMATA EMERGENCY PROCEDURES CHECKLIST, STORM AND SNOW OPTION	45
6-7	WMATA TRACTION POWER GAPS MENU	45
6-8	WMATA INTERLOCKINGS GRAPHICS	45
6-9	PATCO FIRE EMERGENCY DATA SET	46
6-10	PATCO THIRD RAIL DATA, CODING AS OF SEPTEMBER 1983	46
6-11	RETRIEVAL OF PATCO DATA ON LOCATION, FIRST OF FOUR SCREENS	46
6-12	RETRIEVAL OF PATCO DATA ON LOCATION, SECOND OF FOUR SCREENS	46
6-13	RETRIEVAL OF PATCO DATA ON LOCATION, THIRD OF FOUR SCREENS	47
6-14	RETRIEVAL OF PATCO DATA ON LOCATION, LAST OF FOUR SCREENS	47
6-15	PATCO HIGH-VOLTAGE CIRCUIT-RETRIEVAL MENU	47



## LIST OF FIGURES (Cont.)

<u>Figure</u>		<u>Page</u>
6-16	PATCO HIGH-VOLTAGE CIRCUIT-RETRIEVAL MENU, CIRCUIT 301 (13.2 Kv)	47
6-17	PATCO NEW JERSEY HIGH-VOLTAGE CIRCUIT GRID	48
7-1	AERS II DEVELOPMENT PLAN	50
7-2	GENERALIZED AERS II	53

## LIST OF TABLES

<u>Table</u>		<u>Page</u>
3-1	SUMMARY OF DATA DISPLAYED WHEN RETRIEVING DATA ON A LOCATION	11
7-1	FUNCTIONAL GOALS AND OBJECTIVES	52
7-2	SYSTEM-ORIENTED GOALS AND OBJECTIVES	52
7-3	DATA SPECIFICATION LIST	54
7-4	EMERGENCY ACTION SPECIFICATION LIST	56



## 1. INTRODUCTION

This report presents the results of an effort to deploy and evaluate automated emergency response systems (AERS). Developed initially by a train controller at the Bay Area Rapid Transit District (BART), the AERS is a computerized data bank containing equipment and facilities location information and predetermined response actions. Its purpose is to provide controllers, dispatchers and supervisors with a quick and accurate information retrieval system. In the development of UMTA's Recommended Emergency Preparedness Guidelines for rail transit systems, the AERS was identified as a decision-making aid that would be of value to the transit industry. The UMTA Office of Technical Assistance Safety and Security Staff, supported by the Transportation Systems Center (TSC), acquired this initial AERS from BART and demonstrated it at several transit meetings and transit systems.

The basic features of the BART AERS are as follows:

1. The software had been under development since 1979 and is now fairly complete as a tool for controller/dispatchers.
2. The software was designed by a controller for controller/dispatchers.
3. The software was developed for an Apple II Plus<sup>TM</sup> microprocessor - a relatively inexpensive, 8-bit, portable personal computer.
4. The software is written in the (Applesoft) BASIC computer language, which is a relatively simple programming language.
5. The Apple II Plus computer is relatively easy to transport (the computer, printer, and video monitor travel in three suitcases and the programs, or software, are on two 5-1/4 inch floppy diskettes).
6. Cost and space requirements of the Apple computer allow multiple units in a control room to provide a highly reliable, accessible AERS capability.

The deployment and evaluation of the AERS was conducted at the Washington Metropolitan Area Transit Authority (WMATA) and the Port Authority Transit Corporation (PATCO) of Pennsylvania and New Jersey. Each transit system was provided with software similar to the BART AERS microprocessor and other

hardware, data sets tailored to represent a portion of their respective systems, and training in the operational AERS and the programming behind the software. BART assisted TSC in providing both the software and training.

The following sections provide a more detailed description of this effort and of plans for the next generation AERS. Section 2 gives a brief overall description of the AERS. Section 3 describes the BART AERS, the parent AERS which has been under development since the Transbay Tube Fire in 1979. Sections 4 and 5 describe the WMATA and PATCO demonstration efforts, and section 6 describes the present status of the AERS. Finally, section 7 contains a brief description of the effort to develop a generalized, generic AERS software capable of being easily modified and installed at virtually any transit system.



## 2. DEFINITION OF AERS

The current AERS, depicted graphically in Figure 2-1, is an Apple II Plus microprocessor-based set of BASIC programs that: (1) retrieves data on a location; (2) displays data base entries; (3) updates data base entries; and (4) displays site-specific data to meet the unique requirements of the transit systems.

The AERS data base may be visualized as a two-dimensional array or matrix in which the rows refer to locations and the columns refer to data attributes (fans, dampers, fire departments, etc.). Thus, AERS can be described as a specialized computer-based information retrieval system that is designed to display data on a location (across a row) or on a data element (down a column). AERS also contains the following characteristics:

1. Quickly displays track and track-related data items that are contained in the files.
2. Features computer video displays and printed output organized to provide meaningful data for use by the supervisors and controller/dispatchers during any normal or abnormal situation.
3. Is on-line during all periods of operation, whether the system is in service for revenue or for track maintenance.
4. Operates independently of the transit system's mainframe computer.
5. Consists of multiple units providing a highly reliable uninterrupted supply of data during all operating periods.
6. Has a data base which can be verified by the transit system.
7. Has utility programs to maintain the data base, etc.

The two unique elements of the AERS are the data base and hardware. The following two sections define these AERS elements.

### 2.1 DATA BASE

As noted above, the AERS data base element may be visualized as a two-dimensional array or matrix of data. The columns of the array (i.e., the AERS

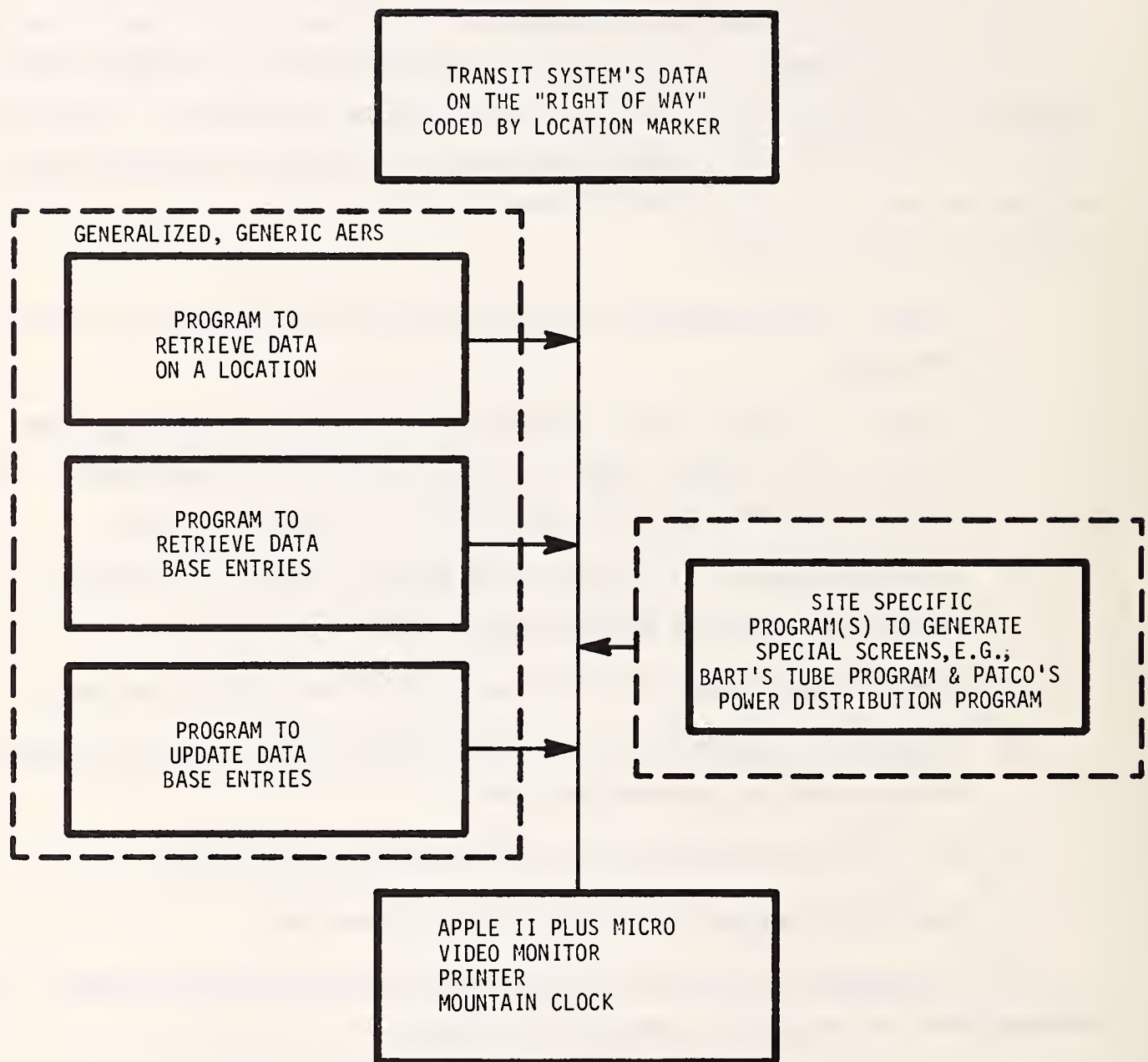


FIGURE 2-1. AERS SCHEMA

data files, data sets, etc.) represent a set of files containing track and track-related data arranged by location marker - i.e., line and mileage markers or line and chain markers. For the purposes of this report, line and mileage markers or line and chain markers are called location markers.

Data elements in the files include reference and operations data such as: (1) third rail switches; (2) interlockings; (3) access points; (4) station names; (5) cross-passages in subways, tunnels, and tubes; (6) station phones; (7) maintenance of way access points; (8) emergency phones; (9) fire and/or police department jurisdiction and emergency phones; and (10) intersecting streets.

For the purposes of this report, it is assumed that the AERS files contain only track and track-related data for practical application, especially during abnormal periods. Operating information such as schedules, daily passenger loads, etc., though stored and reported using the same equipment, is not covered in this report.

## 2.2 HARDWARE

The current AERS hardware deployed at WMATA and PATCO consists of an Apple II Plus microprocessor (48K), an Epson<sup>TM</sup> printer, a GE video monitor, a 5 1/4 inch floppy diskette disk drive, and a Mountain clock. BART has four sets of similar equipment.

The video monitor (CRT screen) and printer provide at present the only means of output from the AERS. The video monitor displays may be categorized as follows:

1. Main menu displays, which identify the principal options (functions) and accept the user-defined selections as input to the programs.
2. Subordinate menu displays, which are accessible through the main menu or other subordinate menus.
3. Video output displays for emergency actions, showing the information retrieved as a result of user input on a subordinate menu. In the BART AERS, this consists of ventilation and evacuation information for the Transbay Tube and the Berkeley Hills Tunnel.

4. Other video monitor displays, including such displays as the agency's logo, and listings of items being revised.

There are currently two options for generating printed output: (1) print what is on the screen simultaneously, or (2) print what is on the screen optionally before the next video display is outputted by the microprocessor.



### 3. BART AERS

A fire on a train in any section of a transit system can be extremely hazardous. The degree of hazard varies from section to section, depending on whether the section is underground or aerial, has special ventilation requirements, is not easily accessible, and so on. One such section at BART is the Transbay Tube, a three and one-half mile segment under the San Francisco Bay between Oakland and San Francisco. BART AERS was developed in response to the 1979 Transbay Tube fire.

One of the critical elements of fire emergency response in the Transbay Tube is establishing proper ventilation so that passengers are exposed to minimal quantities of smoke. This requires the ability to remotely open one of the many dampers (which are normally closed) to the exhaust duct, which then carries the smoke to the ends of the tube for venting. After the appropriate damper is opened, the supply and exhaust fans are activated and the smoke is carried away to both the Oakland and San Francisco ends of the tube. This procedure is more complicated than would appear at first glance. Establishing ventilation in the tube requires an integration of a number of variables, including: (1) train length; (2) location in the tube; (3) fire location; and (4) ventilation regime for the specific location so as to ventilate the smoke over the fewest number of cars and passengers.

When, in 1979, a fire did occur, central controllers had to quickly and accurately determine proper ventilation and evacuation schemes under critical conditions. The operation was enormously complex due to the volume of hard copy data (maps, engineering drawings, etc.) required to evaluate and choose among a variety of strategies for evacuation, removal, and rescue, with each strategy involving different mixes of electrification and de-electrification. The situation was further complicated because the control room staff did not know the exact location of the train or extent of the fire. Because of the volume of data, the differing alternative response requirements, and the complication of not knowing

the location of the train or the extent of the fire, the customary manual method of response proved inadequate.

### 3.1 MICROPROCESSOR SELECTION

At the time of the fire in 1979, BART management had been considering using one of its mainframe computers for an emergency action support system. Various means to provide full-time, on-line, real-time access for central control staff, using a computer that was periodically off-line for maintenance, were under consideration. Some approaches, such as procuring a back-up computer, or linking dissimilar computers to back up one another when one is off-line for maintenance, would have been expensive and time-consuming.

The management study showed that the transit system needed a moderately priced computational and retrieval capability that would be available 100 percent of the time. Redundant Apple II Plus microprocessors met these requirements.

Central control was provided with the resources to purchase equipment and to develop the AERS. The initial development of the AERS concentrated on the emergency action module designed specifically for the Transbay Tube. Later, the system was expanded to include the Berkeley Hills Tunnel, and eventually all locations. The AERS currently contains a number of modules designed to meet the information needs of the control room staff and higher management. There are at present four Apple II Plus computers in central control. It should be remembered that the software was designed to be an aid to the controllers and not to replace the officially approved standard operating procedures manuals used in central control.

### 3.2 BART AERS SOFTWARE INTRODUCTORY NOTES

For the purposes of this document, two common BASIC computer terms - function and menu - will be used. A function is a programmed interactive query, and a menu is a list of functions. An abbreviated main menu for the BART AERS is shown in Figure 3-1. (This abbreviation is explained in Section 3.3.) The next four sections discuss the three functions identified in Figure 3-1 in the following order: (1) obtaining data on a location; (2) displaying data base entries; (3) determining emergency actions for a location in the Berkeley Hills Tunnel; and (4) determining

emergency actions for a location in the Transbay Tube. Note that the corresponding figures are presented on page 17-22.

### 3.3 SOFTWARE TO RETRIEVE DATA ON A LOCATION (FUNCTION 2)

BART's main menu, as shown in Figure 3-1, displays only three of the six functions that the user can currently select: emergency action software; displaying data on a location, and displaying all of the data base entries. (The other three functions pertain to central control responsibilities and so will not be covered in this document). The main menu (generated using a program named INPUT) prompts the user to enter a numeric value to identify the specific routine that the program is to follow.

Assume that the user selects the second function, i.e., displaying data on a location. Figure 3-2 shows that after selecting the function, the user is then prompted for the input required for that specific routine. In this instance, the user is prompted to enter the location in one of four acceptable formats. Mileage marker and line are self-explanatory. The others, called zone codes, are codes for stations, interlockings, maintenance of way access points, maintenance yards, etc.

At BART, these zones are usually coded with a three- or four-digit alphanumeric designation as follows:

1. A-line stations from Lake Merritt to Fremont, A10 to A90 ascending by 10.
2. M-line stations from Oakland West to Daly City, M10 to M90 ascending by 10 (except for Embarcadero, which is M16).
3. C-line stations from Rockridge to Concord, C10 to C60 ascending by 10.
4. R-line stations from Ashby to Richmond, R10 to R60 ascending by 10.
5. K-line stations from 12th Street Oakland to MacArthur, K10 to K30 ascending by 10.
6. Maintenance of way access points, such as MW02 on the M-line at Milepost 13.12.
7. Others, such as A05 Oakland WYE and A15 Oakland Shop.



Figure 3-3 shows the retrieval of location data for location 5.5 C - that is, mileage marker 5.5 on BART's C-line. Note that this area is in the Berkeley Hills Tunnel and is also covered in the emergency action option. Table 3-1 identifies generically, by type of area, the data that the software displays when retrieving data on a location.

### 3.4 SOFTWARE TO DISPLAY DATA BASE ENTRIES (FUNCTION 3)

The data base entries display is the last of three functions shown on the main menu (see Figure 3-1). If the user, by entering the number 3, selects this function, the screen then prompts to enter the "attribute" of data to be displayed, such as access points, cross streets, or fire department jurisdictions (Figure 3-4). Assume, for example, that the user wants to display the data on the type of area (transitions). Once the appropriate number has been entered (in this instance, "8"), the user is prompted to enter the letter designating a specific line (Figure 3-5). After the line has been entered, the screen displays the data on that attribute for each reference mileage marker (C-line transitions are shown in Figures 3-6 and 3-7).

Note that at the bottom of the screen in Figure 3-6, three prompts are given: (SPACE), (RETURN), and 1-6. In order to view additional "pages" of data (when they exist) for that attribute, the user should enter a space; up to 25 lines of data will be displayed on each screen. To return to the main menu, the user should enter a carriage return. Finally, by entering a number between 1 and 6, the user can return directly to whichever function he or she desires.

Figures 3-8 through 3-14 present the displays for the remaining attributes on the C-line. (Note that only one "page" of data is given for each attribute.)

### 3.5 BART AERS - EMERGENCY ACTION SOFTWARE FOR THE BERKELEY HILLS TUNNEL (FUNCTION 1)

The first function on the main menu is "determine emergency actions." The emergency action module consists of two major programs: (1) BHT for the Berkeley Hills Tunnel and (2) TUBE for the Transbay Tube. The latter is described in Section 3.6.



TABLE 3-1. SUMMARY OF DATA DISPLAYED WHEN RETRIEVING  
DATA ON A LOCATION

	Type of Area			
	Station Interlock Maint. of Way	Subway (Between Stations)	Aerial	Grade
	Approp. Zone Code	Milepost Line	Milepost Line	Milepost Line
<p><u>Input Data Entered</u></p> <p><u>Data Displayed</u></p> <ul style="list-style-type: none"> <li>• Area</li> <li>• MUX (Train Control Area)</li> <li>• Interfaces (Both Directions)</li> <li>• Rail Number (Both Directions)</li> <li>• Fire Department</li> <li>• Station Phones</li> <li>• Access Points</li> <li>• Cross Street (within ½ mile)</li> <li>• Ventilation Facilities</li> <li>• Distance to Next Zone (Station) (Both Directions)</li> <li>• Western Pacific</li> <li>• Milepost &amp; Controller Phone Number (when applicable on the A line)</li> </ul>	<p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p>	<p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p>	<p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p>	<p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p> <p>X</p>

The unique physical characteristics of the 3-1/2 mile Berkeley Hills Tunnel are: (1) portal doors at the Orinda side of the tunnel that are normally (but not always) closed as part of the ventilation scheme; (2) ventilating fans that, if run, can be run either in supply or exhaust; (3) cross-passage doors at 1000-foot intervals; (4) a metal grate walkway with a railing along the side of the tunnel; and (5) a high tension line running along the top of the tunnel.

The BHT program is used to assess any abnormal situation that could require ventilating the tunnel, because the software indicates (1) whether or not to close the portal doors and (2) whether to run the ventilation fans in supply or exhaust.

Figures 3-15 through 3-19 show screens generated by the emergency action function. Figure 3-15 gives the first emergency action screen. This display is used to prompt the user to input the data which will determine whether the area is covered by the BHT or Tube software. (In this case, the user entry of 5.5 C designates the BHT.) Note that the user input for the first prompt conforms to one of six acceptable formats:

1. mileage marker, line and track
2. mileage marker, line, track and reverse running
3. zone and track
4. zone, track and reverse running
5. two adjacent zones
6. two adjacent zones, track and reverse running

The user is then prompted to enter the length of the train, which is a key variable in BART's ventilation scheme ( Figure 3-16). In response to this prompt, 6 has been entered for a 6-car train. The next prompt requests information about the location of the fire ( Figure 3-17). There are five acceptable fire location entries:

1. the exact car number
2. front of the train
3. middle of the train
4. rear of the train
5. unknown

"Unknown" has been entered, and Figure 3-18 shows the resulting screen prior to program execution.

Figure 3-19 shows the screen for the same location and train length in the Berkeley Hills Tunnel, but now the fire is isolated on a front car. Note that this screen shows some of the information contained in Function 2, retrieve data on a location. It also includes: (1) the instruction to run the ventilation fan in exhaust; (2) the location of the nearest cross-passage doors; (3) the identifying numbers of emergency phones; (4) the switch for the 34.5 KV cable; and (5) the distance to the portal.

The BART AERS programs were written to edit or check the user input. For example, Figure 3-20 shows the screen display for a section of the system for which no emergency action software has been written. Note that the user can either input a new location or make a carriage return to go to another menu.

### 3.6 BART AERS - EMERGENCY ACTION SOFTWARE FOR THE TRANSBAY TUBE (FUNCTION 1)

Before the Transbay Tube program is discussed, an explanatory note on the structure of the tube would be useful. Figure 3-21 gives some of the emergency instructions currently contained in each transit vehicle. As shown in the top two graphics, the tube's two outer sections contain the tracks and walkways. The walkways, which run along the inside of each track, are principally at the door level of the vehicle, except when the walkways descend to the track level at the cross-passage doors. The rectangular space in the middle is the gallery, which contains assorted equipment, including rescue and fire fighting equipment. If evacuation is required, the current plan is to evacuate through the gallery to the other track.

The software for the Tube program is similar to that described in section 3.5 for the Berkeley Hills Tunnel. When the train location has been entered according to format, the input program checks the value of the location to determine whether this corresponds to the values for sections in either the Berkeley Hills Tunnel or the Transbay Tube. (Since there is no special ventilation scheme for the remainder of the system, input on smoke location and length of the train is required only for the tunnel and tube.) If the location entered



is within the appropriate mileage markers on the M-line, the user is then prompted to enter a train length of between 3 and 10. As mentioned previously, an inaccurate entry will not be accepted. The user is then prompted to enter a value for the location of the fire. Only five options are permitted: (1) an exact value between 1 and 10 to identify the specific car; (2) "F" for front of the train; (3) "R" for rear of the train; (4) "M" for middle of the train; and (5) "U" for unknown.

Figure 3-22 shows the output for an emergency action inquiry involving a Transbay Tube value, 4.6M2 (mileage marker 4.6 on the M-line's Track No. 2), for the location of the train; 5 as the length of the train; and F as the location of the fire. The M-line and Transbay Tube codes shown in Figure 3-22 are as follows: (1) BV = exhaust fans; (2) MV = supply fans; (3) DR = cross-passage door; (4) BD = damper; (5) M = emergency phone; and (6) MR = third rail section.

A number of items on Figure 3-22 should be noted. First, the display shows in outline format many of the items in BART's standard operating procedure. Some procedural items are not shown, such as a prompt for notifying the San Francisco and Oakland fire departments via the hot line. Second, the user input can be revised simply by entering the appropriate number in the "Revise #" prompt. Using the "Revise #" prompt does not always affect the program-generated values shown on the display. Obviously, the values will change if the location of the train is changed. Also, by changing the length (the numbers of cars), other values, such as "Rear A" values and the number of the car located at a cross-passage door, will change. The damper to be opened might change if the fire location (number 3) changes, because the algorithm is programmed to vent the smoke over the fewest cars.

Finally, virtually all the values displayed are calculated in the Transbay Tube program and are not taken from the AERS files. Speed and accuracy are two principal reasons for this. It is faster to calculate these values than to search the files, obtain the values, and display them. Also, because there is no data to be entered into the files, there is no chance of input errors or of displaying erroneous data from damaged data sets. This ability to calculate the values of the items is a result of the uniformity in the design and construction of the Transbay Tube, in which 300-foot uniform, pre-cast sections were towed to the site, maneuvered into position, flooded, sunk, joined together, and eventually pumped out.



As a result of using uniform 300-foot sections, all values can be calculated using 300 feet as the baseline. Track features, therefore, maintain a numerically constant relationship. For example, the cross-passage doors (DR) are numbered sequentially, and the emergency phones (M) are numbered sequentially odd or even depending on the track (odd on the even numbered track and even on the odd-numbered track). Dampers (BD) are numbered with even numbers on the even track.

The major difficulty in the Transbay Tube is that the uniformity can cause train operator disorientation, resulting in an inability to determine the exact location of the train in the tube. In fact, in the Transbay Tube fire of 1979, the operator experienced difficulty in pinpointing the train location for the controllers. As a result, some additional, easily read identification markers have been added: mileage markers (eventually placed every 50 feet); large numbers painted on the yellow cross-passage doors; numbers to identify the emergency phones, etc.

### 3.7 PROGRAMS TO MAINTAIN THE FILES

Figure 3-23 shows the BART file maintenance functions and Figure 3-24 shows some of the files maintained. Two control features have been incorporated in the BART file maintenance update process. First, only one supervisor is allowed to update the files. This ensures supervisory accountability for any errors contained in the various files. Second, the software requires the user to review the updated information before it is written onto the file.

### 3.8 OTHER FEATURES IN THE BART SOFTWARE

Additional software has been added to the BART AERS installation to handle special control room functions, such as controlling access to the AERS data base; displaying schedules and expected departure times over a brief period of time; updating train schedules; collecting and displaying daily performance statistics; and displaying messages at an appropriate time, including special maintenance work being performed. These functions are itemized as functions 4 through 6 on the main menu. Because the functions are not applicable to AERS, they are not documented or discussed in this report.

### 3.9 SUMMARY

BART originally purchased its microprocessors to implement an "Emergency Actions" program, but soon realized that the computers could perform additional emergency and operational data retrieval tasks. The ability of the computer to maintain and operate a data base led to the implementation of an additional function: the display of relevant information that a central controller may need for any location in the transit system. This eliminated the problem of accessing information recorded in different places by making all necessary information easily obtainable from a single source.

In summary, prior to AERS, it was necessary in the event of an emergency to:

1. Consult procedures and, if applicable, the Emergency Plan.
2. Consult Decision Trees (as required).
3. Consult Track Maps.
4. Consult emergency ventilation regimes (as required).
5. Determine fire jurisdictions, if applicable.
6. Double-check information.
7. Disseminate information.

The microprocessor has achieved the following objectives:

1. Provides rapid access to information.
2. Ensures accuracy of information.
3. Reduces error potential.
4. Ensures consistency of results.
5. Concentrates all required emergency information in a single location.

# BART INFORMATION RETRIEVAL SYSTEM

## FUNCTIONS:

- 1 DETERMINE EMERGENCY ACTIONS
- 2 GET DATA ON A LOCATION
- 3 DISPLAY DATA BASE ENTRIES

RETURN TO THIS MENU

ENTER ---> <RETURN>, 1-3

FIGURE 3-1. BART MAIN MENU

## MILEPOST 5.5 C-LINE IS:

1.13 MILES FROM C15 {4 MIN. IN R/M}

2.61 MILES FROM C20 {8 MIN. IN R/M}

AREA: BERKELEY HILLS TUNNEL

IN THE C20 MUX °  
INTERFACES: 5.23, 11.46

RAIL: C-1: CR05 C-2: CL05

F/O TO CALL: OAKLAND / ORINDA

ACCESS: 4.57: MW09  
7.93: MW10

VENTILATION: WEST PORTAL {MP 4.64}  
CU15/16 {MP 7.84}

ENTER ---> <RETURN>, 1-6

FIGURE 3-3. DATA RETRIEVAL ON A LOCATION  
(FUNCTION 2); RETRIEVAL FOR  
5.5 MILEPOST ON THE C-LINE

## 1 LOCATION ?

## ACCEPTABLE FORMATS:

<MILEPOST> <LINE>

<ZONE>

<ZONE> - <ZONE>

<M/W ACCESS>

FIGURE 3-2. DATA RETRIEVAL ON A LOCATION  
(FUNCTION 2)

## DO YOU WANT INFORMATION FOR:

1. FANS/PORTALS/VENTS
2. ACCESSES/STATIONS
3. STREETS
4. TRAIN CONTROL INTERFACES
5. 3RD RAIL-TK 1
6. 3RD RAIL-TK 2
7. FIRE DEPTS
8. TYPE OF AREA

INPUT NUMBER REQUESTED: ■

FIGURE 3-4. RETRIEVAL OF DATA BASE ENTRIES  
(FUNCTION 3)



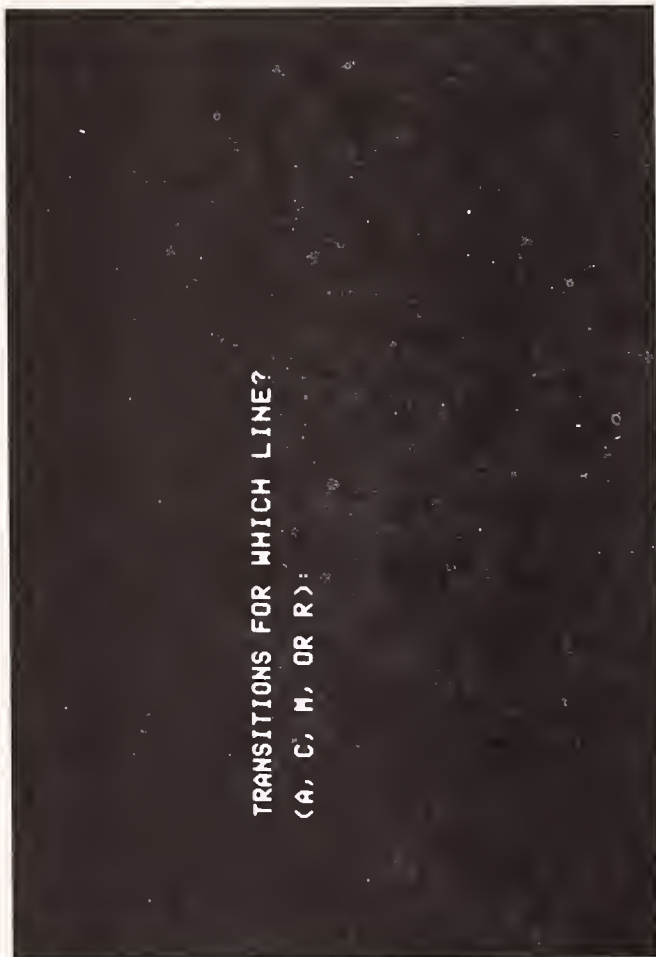


FIGURE 3-5. SUBORDINATE MENU FOR RETRIEVING DATA BASE ENTRIES (FUNCTION 3)



FIGURE 3-6. RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE TRANSITIONS



FIGURE 3-7. RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), SCREEN 2 OF C-LINE TRANSITIONS



FIGURE 3-8. RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE ACCESS POINTS





C-LINE-3FC-RAUL-TK-2

[illegible]

ENTER ---> <RETURN>, 1-6

FIGURE 3-13. RETRIEVAL OF DATA BASE ENTRIES  
(FUNCTION 3), C-LINE THIRD  
RAILS - TRACK 2

```

3 LOCATION ? 5.501 ■
3 LENGTH ?
3 FIRE LOC ?

```

ACCEPTABLE FORMATS:

```
<MILEPOST> <LINE> <TRACK> <'R'>
<ZONE> - <TRACK> <'R'>
<ZONE> - <ZONE> - <TRACK> <'R'>
---ZONES MUST BE ADJACENT
```

FIGURE 3-15. AGENCY ACTION SOFTWARE (FUNCTION 1), FIRST USER ENTRY

C-LINE INTERFACES

[illegible]

ENTER ---> <RETURN>, 1-6

FIGURE 3-14. RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE INTERFACES

1	LOCATION ?	5.501
2	LENGTH ?	6
3	FIRE LOC ?	

ENTER NUMBER FROM 2 TO 10 TO REFLECT  
LENGTH OF INCIDENT TRAIN

FIGURE 3-16. EMERGENCY ACTION SOFTWARE FOR THE BERKELEY HILLS TUNNEL, SECOND USER ENTRY

1. LOCATION ? 5.5C1
2. LENGTH ? 6
3. FIRE LOC ? U

ENTER:

'F' IF AFFECTED CAR IN FRONT  
 'M' IF AFFECTED CAR IN MIDDLE  
 'R' IF AFFECTED CAR IN REAR  
 'U' IF AFFECTED CAR UNKNOWN  
 <NUMBER> LOCATION OF AFFECTED CAR  
 (1 TO 6) IN CONSIST

FIGURE 3-17. EMERGENCY ACTION SOFTWARE FOR  
 THE BERKELEY HILLS TUNNEL,  
 THIRD USER ENTRY

- 1 LOCATION ? 5.5C1
- 2 LENGTH ? 6
- 3 FIRE LOC ? F

REVISE #

<RETURN> TO EXIT

RUN CABLE IN EXHAUST

<CHANGE ONLY IF EVENT CAR CHANGES>

LEAD A IS 633 FT TO DR #16 (E.T. #125)  
 CAR NUMBER 6 IS AT DR #15 (E.T. #123)

GRADE TOWARD MW09 <.78-MI TO PORTAL>

THIRD RAIL SECTION: CR05

34 5KV CABLE: CRC <COR H12>

FIGURE 3-19. EMERGENCY ACTION SOFTWARE FOR  
 THE BERKELEY HILLS TUNNEL,  
 RESULTING DISPLAY

1. LOCATION ? 5.5C1
2. LENGTH ? 6
3. FIRE LOC ? U

PROGRAM LOADING -- STAND BY

FIGURE 3-18. EMERGENCY ACTION SOFTWARE FOR  
 THE BERKELEY HILLS TUNNEL,  
 PROGRAM EXECUTION DISPLAY

1. LOCATION ? 4.5C1
2. LENGTH ? 6
3. FIRE LOC ? U

REVISE # 1

PROGRAM FOR AREA REQUESTED NOT ON LINE

FIGURE 3-20. EMERGENCY ACTION SOFTWARE,  
 C-LINE LOCATION NOT COVERED  
 BY BIT PROGRAM







## 4. DEVELOPMENT AND DEPLOYMENT OF THE WMATA AERS DEMONSTRATION SYSTEM

### 4.1 DEPLOYMENT ACTIVITIES

In response to a request from the Washington Metropolitan Area Transit Authority (WMATA), UMTA, BART and TSC established a deployment team to deploy a version of AERS at WMATA. The demonstration software used at WMATA was patterned after the BART AERS software. Files were established for the C-line (Metro Station to the Washington National Airport Station).

The BART software was converted to fit the WMATA environment. For example, because WMATA uses engineering chain markers instead of the mileage markers used by BART, an appropriate location marker conversion was made. The BART software was also rewritten to:

1. Provide emergency action data showing the WMATA ventilation scheme for the C-line, which employs station fans to vent smoke from the tunnel environment.
2. Retrieve data using station codes similar to the existing 3 digit BART codes. The WMATA station codes were truncated to 3 digits - for example C01 to C10 in place of the C001 to C010 codes used on engineering drawings.
3. Use location indicators consisting of line letters and chain markers to retrieve and update data.

The demonstration system was installed over a three-day period in December 1982. During this time, training sessions were conducted for selected train controller/dispatchers. Separate workshops were conducted for the train control room supervisory staff, the programming staff, management staff and transportation department managers.

Although not all controllers were trained, each of the selected members of the control room staff received at least 10 hours of hands-on training over the three-day period. Specifically, a group of first shift controllers and one supervisor (assistant superintendent) met daily between 9:30 am and 2:00 pm and a similar group of second and third shift controllers and an assistant superintendent met daily between 6:30 pm and 10:00 pm. A major portion of these sessions was

devoted to identifying and discussing specific requirements of the WMATA train control room that were not contained in the demonstration software and data bases.

Managers, supervisors, and management staff in the transportation department, along with staff from other departments, such as the safety staff, attended workshops which were conducted as required.

The WMATA AERS programs were similar to the BART programs. A few of the major changes in input have already been noted. The following sections itemize some of the more noticeable changes. (All of the figures appear at the end of this section, on pages 30-34.) Figure 4-1 shows the main menu, which, though essentially the same as the one at BART, was revised to include utility (data base update) programs and a function to print out data.

#### 4.2 WMATA AERS DEMONSTRATION SOFTWARE - INFORMATION ON A LOCATION (FUNCTION 2)

Screens shown in Figures 4-2 through 4-5 are essentially the same as those on the parent BART AERS. Figure 4-2 shows the first screen generated when the user opts to retrieve data on a location. As in BART AERS software, the acceptable formats are itemized on the bottom of the screen. Figures 4-3 through 4-5 show the screens that result when the location (line, chain marker or station code) is entered in one of the acceptable formats.

#### 4.3 WMATA AERS DEMONSTRATION SOFTWARE - DISPLAYING DATA BASE ENTRIES (FUNCTION 3)

Figure 4-6 gives the attributes available under the display data base entries function. Figures 4-7 through 4-11 show the displays for attributes 3, 5, 6 and 7 respectively. The C-line screens shown here contain the data originally entered for the workshops. While WMATA's menu and attributes for this function essentially duplicate those of the BART AERS, the WMATA data in fact lack the precise detail that characterizes the BART data sets.

#### 4.4 WMATA AERS DEMONSTRATION SYSTEM - PROGRAMS TO UPDATE A FILE (FUNCTION 4)

The WMATA AERS contains a utility program function that allows supervisory personnel to update files. Figures 4-12 through 4-15 show the various prompts involved in the update process. Because nonsupervisory employees at

WMATA do not have access to the microcomputer and AERS software, control of file maintenance updates is of less concern. Thus the update process, which, as at BART, is the responsibility of the supervisors, can be included as a function on the main menu.

#### 4.5 WMATA AERS DEMONSTRATION SYSTEM - EMERGENCY ACTION DATA (FUNCTION 1)

The demonstration emergency action data display contains a rough outline of the ventilation and rescue plan for the transit system's C-line as it existed in December 1982. The plan was provided by the WMATA safety department and covered two situations: (1) fire in a subway tunnel and (2) fire in a station. Because the strategy of the emergency plan is to ventilate the tunnels using the station fans, evacuation of the station(s) through which smoke is being vented will sometimes be required. The emergency action procedures display is designed to indicate such things as when to evacuate a station. Figures 4-16 through 4-18 show sample screens for a fire occurring on the C-line at chain marker 3500 (location marker C 3500) for the WMATA demonstration system.

Figure 4-19 shows the screen for a fire incident occurring at a station, and Figure 4-20 shows the screen for an incident occurring outside of a tunnel. Note that at the time of the demonstration and deployment, WMATA had not identified any areas comparable to BART's Transbay Tube and the Berkeley Hills Tunnel, for which special programs would be necessary. After deployment, however, a number of such areas were identified: Benning Road Station and Tunnel, Capitol Heights Station; and the Addison Road Station and Tunnel. Because they were not part of the C-line, none of these segments was included in the demonstration software and data sets.

#### 4.6 ADDITIONAL REQUIREMENTS IDENTIFIED DURING THE INSTALLATION OF THE DEMONSTRATION AERS

Additional requirements identified by controller/dispatchers and assistant superintendents are presented in this section. The process of identifying the requirements, which proved especially effective, is discussed in section 4.7.

The requirements for central control microprocessors recommended by central control supervisors, and revalidated in a survey of the supervisors conducted in September 1983, are listed below (some of these requirements were not supported by all controllers):



1. Include "+" in chain markers for the AERS software to correlate them with the chain markers shown on engineering drawings, etc.
2. Include the origin for the following alarm points:
  - (a) flammable vapor detectors (FVD alarms)
  - (b) trainway zones
  - (c) speed restrictions
  - (d) fire alarm locations
  - (e) subway drainage pump stations (DPSs)
  - (f) aerial structures
  - (g) gaps in third rail
3. Include other railroad markers parallel to WMATA trainway, e.g., B&O, Conrail, AMTRAK, et al.
4. Add a power map by chain markers.
5. Add the tunnel cross-passages and crossovers which can be used to evacuate a track.
6. Add the closest usable exits (since some exits, ladders in fan shafts for example, are not usable).
7. Highlight switches that are automatically restored.
8. Show a checklist of emergency procedures and information - a print-out of "bullets" outlining the steps. (Note: this has already been done.)
9. Print a checklist for emergencies on which the controllers can insert additional information, such as the name of the fire department official in charge.
10. Add Metro system phone numbers, e.g., train control rooms, maintenance phones, and emergency phones by chain markers.
11. Add chain markers related to vital points, e.g., stations and interlockings.
12. Add station platform graphics for above-ground and underground stations with street address, fire hydrant, normal and emergency exits.



13. Add bus terminal and emergency shuttle stop locations as they relate to train stations.
14. Print a checklist for train troubleshooting, such as for proper closure of doors.
15. Print the general orders affecting train operations.
16. Print a daily operations summary, including statistics on train control activity.
17. Show statistics, such as the monthly operation summary report (graphs and charts).
18. Add train schedules (a low priority item for management).
19. Show the station fans, shaft fans, vent locations and their control points.
20. Add data for additional lines.
21. Show maximum speed limits for all areas of the railroad.
22. Show a graphic layout of the system, including:
  - (a) grade level
  - (b) tunnel, surface, or aerial
  - (c) fan shafts, vent shafts
  - (d) emergency exits

The controllers in the workshops also suggested: (1) implementing a controller exchange program with other mass transit systems; (2) training in APPLESOFT BASIC for controllers; (3) honoring the Rail Transportation Directorate request that chain markers be added to the system in 100-foot intervals; (4) acquisition of additional microprocessors.

As expected, some of the additional requirements were due to the system characteristics and features of WMATA, which are quite different from the BART system. For example, WMATA has an extensive supplemental bus service which can be pressed into service when appropriate. Coordinating service to get the patrons to leave the stations at the proper exits can be a time-consuming process for the staff of central control. Similarly, any activity that requires the controller/dispatchers to get in-house or outside personnel to a specific location at

any station or station exit requires extensive coordination and communications skills. There have been a few instances where buses, firemen and emergency staff arrived at the incorrect station, station platform, station exit, etc.

Due to time constraints and prior commitments, the only requirement addressed during the workshops was the extension of the software to incorporate other lines. Controller/dispatchers and assistant superintendents did in fact add data in their workshops for the K-line (Ballston to Rosslyn stations).

#### 4.7 IDENTIFICATION OF ADDITIONAL REQUIREMENTS AND PRIORITY SETTING

This section discusses the unique process used at WMATA to collect the requirements covered in the preceding section, and shows how the workshop sessions were used to establish the priorities for these requirements. Since no new requirements were initially envisioned, the process of identifying the requirements is briefly described below.

The process began during the first evening's workshop for second and third shift controller/dispatchers. Because the session had proceeded more quickly than expected, the collection of additional AERS requirements was approached a day earlier than originally planned. At first, the controller/dispatchers were surprisingly reluctant to recommend additions. After much prodding, and after assurances that these recommendations would not be taken as criticism of the demonstration system, and that the requirements would be discussed with WMATA management, the compilation of a list began in earnest. Nearly a dozen unique requirements were identified that evening. The next day, the first shift controller/dispatchers followed their lead, and in an almost competitive spirit identified an additional half-dozen requirements.

In summary, conventional techniques for identifying requirements were not used. Instead, the informal brainstorming sessions conducted among the controller/dispatchers and assistant superintendents who actually work in the system produced the requirements listing.

Priority setting was less difficult. A series of management overview workshops was begun in which additional requirements were briefly reviewed and priorities set. The only differences of opinion came in matters relating to schedules, which are low priority items for the safety staff.

#### 4.8 SUMMARY

The demonstration software was successfully deployed and enthusiastically received by the controller staff. (Some controllers, in fact, took programming courses at local educational institutions - on their own time and at their own expense - in order to reprogram and extend the AERS.) Users were trained, management and staff were briefed, and computer support staff provided with details required to extend the demonstration software to other lines. Also, additional requirements unique to WMATA were enumerated.

# METRO INFORMATION RETRIEVAL SYSTEM

## ACTIONS

- 1 DETERMINE EMERGENCY ACTIONS
  - 2 GET DATA ON A LOCATION
  - 3 DISPLAY DATA BASE ENTRIES
  - 4 UTILITY PROGRAMS
  - 5 PRINT CURRENT SCREEN DISPLAY
- RETURN RETURN TO THIS MENU

ENTER RETURN 1-4, P

FIGURE 4-1. WMATA MAIN MENU

CHAIN MARKER 25000 K-LINE IS  
AT K03 (VIRGINIA SQUARE)

AREA: TUNNEL/VIRGINIA SQ S.P.  
3RD RAIL BKRS: K-1: K03-41; K04-31.  
K04-35  
K-2: K03-42; K04-32  
F/O TO CALL: ARL. FIRE DEPT. 527-8900  
VENTILATION: 24057: FK03 (K02)  
26681: FK04 (K03)

ENTER: <RETURN>, 1-4, P

FIGURE 4-3. DATA RETRIEVAL ON LOCATION  
(FUNCTION 2) INPUT FOR K-LINE  
CHAIN MARKER 25000

1 LOCATION ?

## ACCEPTABLE FORMATS:

<LINE> SPACE <CHAIN MARKER>  
<STATION>  
<STATION> - <STATION>

FIGURE 4-2. WMATA DEMONSTRATION AERS,  
DISPLAY INFORMATION ON A  
LOCATION (FUNCTION 2), FIRST  
SCREEN

C03 <FARRAGUT WEST> AT C.M. 4451  
AREA: TUNNEL SECTION  
3RD RAIL BKRS: C-1: C03-31; C04-41;  
C04-45  
C-2: C03-32; C04-42  
F/O TO CALL: D.C. FIRE DEPT 462-1616  
VENTILATION: 3305: FC02 (C03)  
5835: FC03 (C04)  
PHONE: 4303

ENTER <RETURN>, 1-4, P

FIGURE 4-4. DATA RETRIEVAL ON A LOCATION  
(FUNCTION 2) INPUT, STATION CODE



1. LOCATION ? K01-K02

K02 (CLARENDON) AT C.M. 22609  
K01 (COURT HOUSE) AT C.M. 19923

DISTANCE FROM K02 TO K01 IS 2086 FEET  
(.395 MILES)

ENTER: <RETURN>, 1-4, P

FIGURE 4-5. DATA RETRIEVAL ON A LOCATION  
(FUNCTION 2) INPUT, STATION CODE

C-LINE ADDRESS

5400 C TO K CONNECTION TUNNEL (BLUE  
LINE TO ORANGE LINE)  
15850 EMERGENCY EXIT-C2-OUTBOUND  
17180 PORTAL NORTH OF ARLINGTON CEMET.  
EP: STA 8' GATE-C2-OUTBOUND  
17575 8' GATE-C1-INBOUND  
17625 8' GATE-C2-OUTBOUND  
18275 8' GATE-C1-INBOUND  
19075 ARLINGTON CEMETERY STA-C2-OUTBO  
UND NORTH ENTR ESCALATORS AT MEMORIAL DR  
19200 ARLINGTON CEMETERY-C2-OUTBOUND  
300TH ENTR ESCALATORS AT MEMORIAL DR  
30080 8' GATE-C2-OUTBOUND ABOVE RAMP  
TO JEFF DAVIS HWY RTE 110 NORTH  
30100 8' GATE-C1-INBOUND ABOVE RAMP T  
O JEFF DAVIS HWY RTE 110 NORTH  
30570 8' GATE-C1-INBOUND ALONG FOUNDR  
CHANNEL DR

SPACE MORE. <RETURN>, 1-4, P

FIGURE 4-7. DISPLAY DATA BASE ENTRIES  
(FUNCTION 3), C-LINE ACCESS  
POINTS

DO YOU WANT INFORMATION FOR

1. FAN SHAFTS
2. ACCESSES/STATIONS
3. STREETS
4. STATION PHONES
5. 3RD RAIL-TK 1
6. 3RD RAIL-TK 2
7. FIRE DEPTS
8. TYPE OF AREA

INPUT NUMBER REQUESTED: ■

FIGURE 4-6. DISPLAY DATA BASE ENTRIES  
(FUNCTION 3), FIRST SCREEN

C-LINE STREETS

0 G ST. NW & 12TH ST NW  
570 H ST. NW & 12TH ST NW  
890 NEW YORK AVE. NW  
1380 13TH ST. NW  
1500 14TH ST. NW  
1530 14TH ST. NW  
15410 15TH ST. NW  
15550 VERMONT AVE. NW  
15650 15TH ST. NW  
15740 16TH ST. NW  
15810 17TH ST. NW  
15840 17TH ST. NW  
15930 17TH ST. NW  
16090 18TH ST. NW  
16220 19TH ST. NW  
16350 EYE ST. NW  
16530 PENN AVE NW  
16600 21ST ST NW  
16600 21ST ST NW

SPACE MORE. <RETURN>, 1-4, P

FIGURE 4-8. DISPLAY DATA BASE ENTRIES  
(FUNCTION 3), C-LINE STREETS

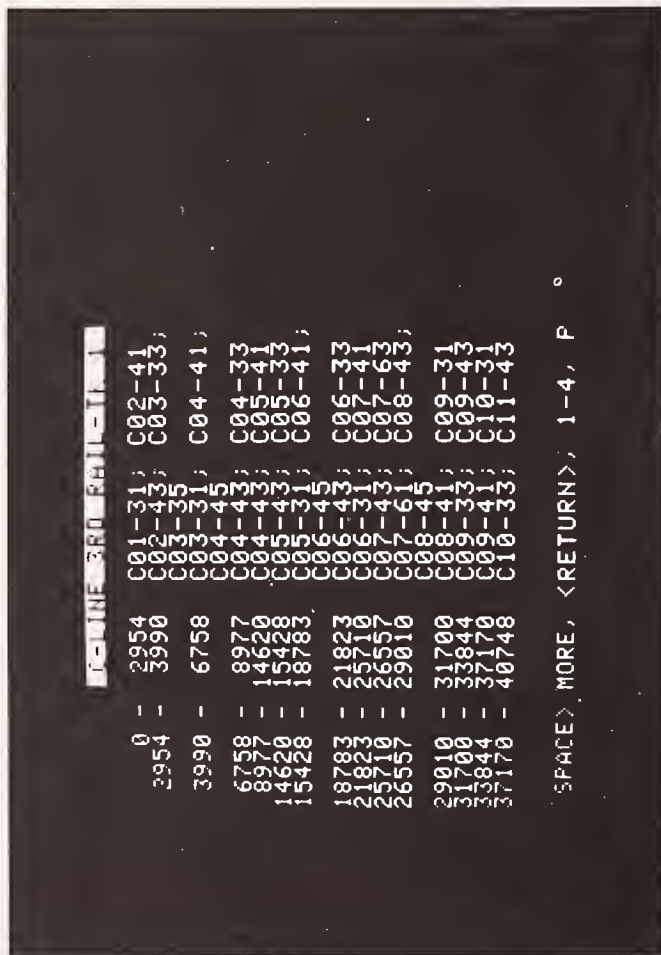


FIGURE 4-9. DISPLAY DATA BASE ENTRIES  
(FUNCTION 3), C-LINE THIRD RAIL  
TRACK NO. 1

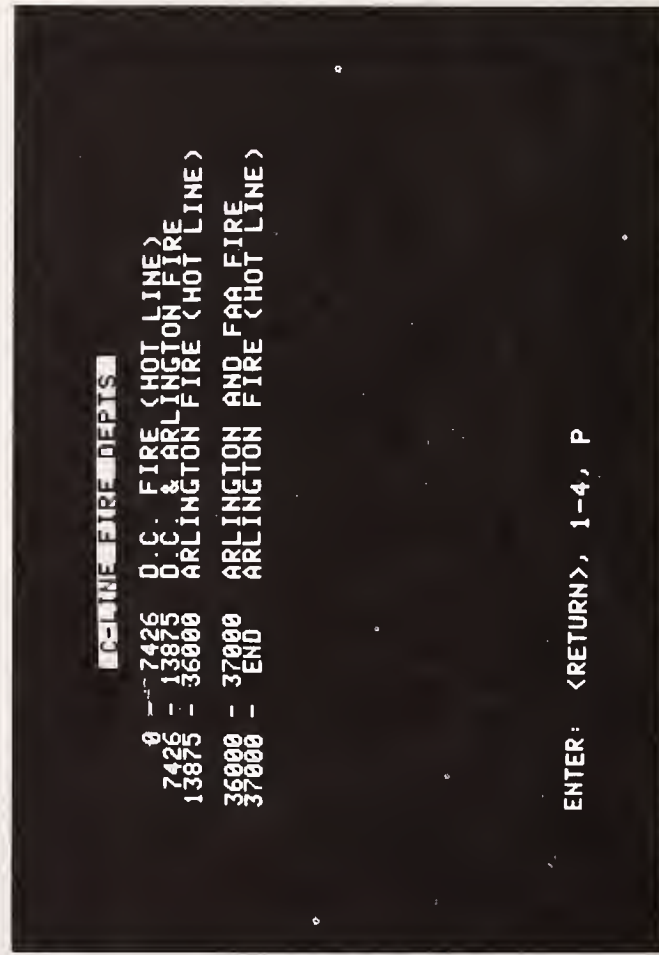


FIGURE 4-11. DISPLAY DATA BASE ENTRIES  
(FUNCTION 3), C-LINE FIRE  
DEPARTMENTS

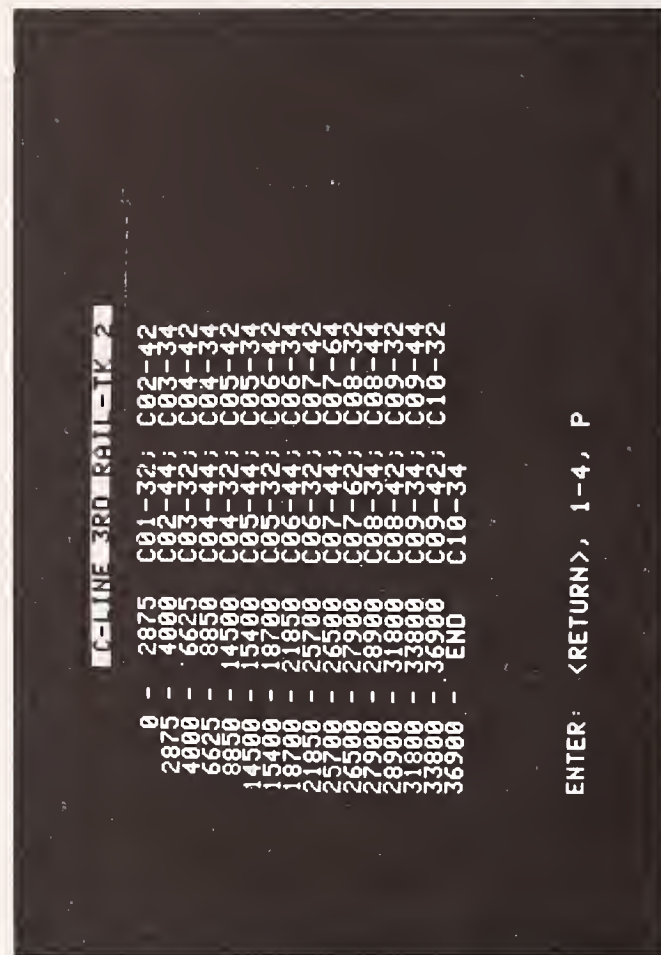


FIGURE 4-10. DISPLAY DATA BASE ENTRIES  
(FUNCTION 3), C-LINE THIRD  
RAIL TRACK NO. 2

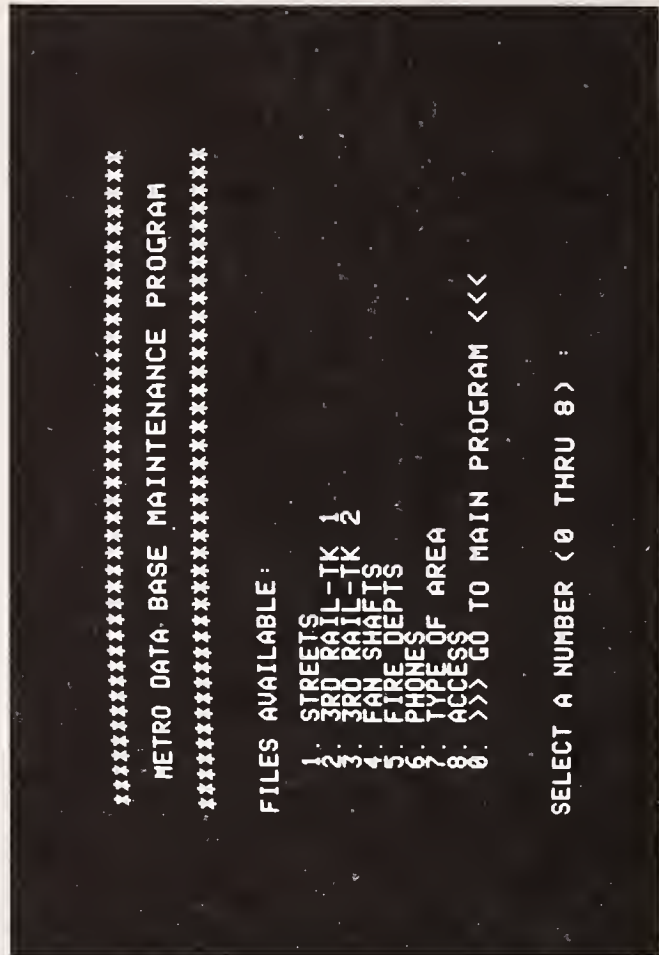


FIGURE 4-12. FILE MAINTENANCE SOFTWARE  
(FUNCTION 4), FIRST SCREEN

```
*****
WAYSIDE INFORMATION CREATION PROGRAM
*****
```

# FUNCTIONS POSSIBLE:

1. ADD ENTRIES
2. DELETE ENTRIES
3. REUSE ENTRIES
4. PRINT LIST OF ENTRIES
5. SEARCH FOR ENTRIES
6. SAVE FILE TO DISK
7. RETURN TO MAIN MENU

SAVE TO DISK BEFORE GOING TO MENU

SELECT A NUMBER (1 THRU 7) :

CURRENT FILE: C-LINE TRANSITIONS

FIGURE 4-13. FILE MAINTENANCE SOFTWARE (FUNCTION 4), SECOND SCREEN

WHAT IS THE NAME OF THE ITEM YOU WANT?  
HINT: TO INCREASE THE CHANCE OF FINDING THE PROPER LOCATION, INPUT THE FEWEST NUMBER OF CHARACTERS WHICH WILL DEFINE THIS AREA.

ITEM: NEW

890 NEW YORK AVE NW  
7635 NEW HAMPSHIRE AVE NW & EYE ST N  
H

ANOTHER SEARCH (Y/N) ?

CURRENT FILE: C-LINE STREETS

FIGURE 4-15. FILE MAINTENANCE SOFTWARE (FUNCTION 4), SEARCHING A FILE BY RETRIEVING AN ITEM

DO YOU WANT TO SEARCH BY:

1. LOCATION
2. ITEM

INPUT '1' OR '2' :

CURRENT FILE: C-LINE STREETS

FIGURE 4-14. FILE MAINTENANCE SOFTWARE (FUNCTION 4), SEARCHING A FILE

1. LOCATION ?
2. TRACK ?
3. LENGTH ?
4. FIRE LOC ?

ACCEPTABLE FORMATS:

<LINE> SPACE <CHAIN MARKER>  
<STATION>

FIGURE 4-16. EMERGENCY ACTION DATA (FUNCTION 1), FIRST SCREEN



1 LOCATION ? C 3500  
2 TRACK ? 1  
3 LENGTH ?  
4 FIRE LOC ?

ENTER EITHER 2, 4, 6, OR 8 TO REFLECT  
THE LENGTH OF THE INCIDENT TRAIN

FIGURE 4-17. EMERGENCY ACTION DATA (FUNCTION 1), SECOND SCREEN

1 LOCATION ? C03  
2 TRACK ? DOESN'T MATTER  
3 LENGTH ? DOESN'T MATTER  
4 FIRE LOC ? DOESN'T MATTER

RUN ~~EXHAUST~~ FC02 (C03) FC03 (C04)  
RUN IN ~~SUPPLY~~ IF FIRE ON MEZZANINE.  
RUN ADDITIONAL FANS IF NECESSARY  
EVACUATE AT FARRAGUT WEST (X4303)  
3RD RAIL BKRS: C-1: C03-31; C04-41;  
C04-45  
C-2: C03-32; C04-42  
F D TO CALL D C FIRE DEPT 462-1616

ENTER <RETURN>, 1-4, P

FIGURE 4-19. RETRIEVAL OF EMERGENCY ACTION DATA (FUNCTION 1) BY STATION CODE

1 LOCATION ? C 3500  
2 TRACK ? 1  
3 LENGTH ? 6  
4 FIRE LOC ? F

~~EXHAUST~~ FC02 (C03)  
~~SUPPLY~~ FC03 (C04)

EVACUATE TOWARD FARRAGUT WEST (4303)

3RD RAIL BKRS: C-1: C02-43; C03-33  
C-2: C02-44; C03-34

F D TO CALL D.C. FIRE (HOT LINE)

ENTER <RETURN>, 1-4, P

FIGURE 4-18. EMERGENCY ACTION DATA (FUNCTION 1): C-LINE, CHAIN MARKER 3500, 6-CAR TRAIN, FIRE LOCATION IN FRONT

1 LOCATION ? C 35000  
2 TRACK ? 1  
3 LENGTH ? 6  
4 FIRE LOC ? F

THAT AREA IS NOT IN A TUNNEL  
NO VENTILATION REQUIRED

3RD RAIL BKRS: C-1: C03-41; C10-31  
C-2: C03-42; C10-32

F D TO CALL ARLINGTON AND FAA FIRE

ENTER <RETURN>, 1-4, P

FIGURE 4-20. RETRIEVAL OF EMERGENCY ACTION DATA (FUNCTION 1) BY LINE AND CHAIN MARKER



## 5. DEVELOPMENT AND DEPLOYMENT OF THE PATCO AERS DEMONSTRATION SYSTEM

While the WMATA AERS Demonstration software was being programmed and deployed, UMTA, TSC, BART and PATCO were making arrangements for the PATCO AERS demonstration to be deployed in February 1983. This was part of an effort by PATCO to introduce additional automation into the Center Tower Building where central control dispatching, fare collection and related functions are performed.

The TSC and BART AERS deployment team was reassembled. Programming was simplified because there were no special ventilation requirements for any point on the transit system, and therefore no emergency action software was needed. The major modification was to expand the "retrieve data on a location" function to a two page CRT display.

### 5.1 DEPLOYMENT ACTIVITIES

In February 1983, the demonstration software was installed in Center Tower, Camden, New Jersey. Because there was no emergency action software, the training sessions were abbreviated and each controller/dispatcher received approximately five hours of training.

The two-day PATCO training sessions were similar to the three-day WMATA sessions. Two sets of controller/dispatcher training sessions were held each day in Center Tower. A major portion of the training sessions was devoted to identifying PATCO-specific requirements.

Programming staff were included in the first shift session of the first day. Managers and staff were provided with overview workshops in the afternoon of the second day. Also, each of the three supervisors in Center Tower attended at least one session, while covering the normal operations for their staff who attended the training sessions. The first training session was videotaped to assist in future training of additional staff. Finally, on the second day, two management briefing sessions, which included the top management and staff of PATCO and invited guests from the Southeastern Pennsylvania Transit Authority (SEPTA), were held.

At the conclusion of the training sessions, the equipment was installed at one of the controller/dispatcher consoles. As at WMATA, PATCO was loaned an

APPLE II Plus microprocessor with one disk drive, an Epson printer, a GE video monitor, and assorted software and supplies were also provided.

## 5.2 PATCO AERS DEMONSTRATION SOFTWARE - MAIN MENU

All figures appear at the end of this section, pages 39-40. Figure 5-1 shows the main menu. Note that Functions 3 and 4 have been deleted, since they deal with setting the time on a clock and leaving messages, which are not covered in this document.

## 5.3 PATCO AERS DEMONSTRATION SOFTWARE - DATA ON A LOCATION (FUNCTION 1)

Unlike the BART and WMATA programs, the data retrieval software was programmed to display the location data on two screens. A sample output is shown in Figures 5-2 and 5-3. Note that the data points are exactly as the transit system provided them on the various documents furnished to TSC for coding. The data points are in civil engineering terms, such as Center Line (C/L), etc.

As will be shown in a later section, these TSC-coded data points have almost all been transformed by central control supervisors into the day-to-day vernacular of PATCO's Center Tower.

## 5.4 PATCO AERS DEMONSTRATION SOFTWARE - DISPLAY DATA BASE ENTRIES (FUNCTION 2)

The display data base entries function, the second major way to retrieve data, is similar to the BART and WMATA versions of the software. Sample outputs are shown in Figures 5-4 and 5-5. Only a few of the screens are given here, since they are generally the same as the formats shown in previous selections. The present samples were selected deliberately to show the changes made by PATCO staff between February and December 1983. These changes are discussed in more detail in the next section.

## 5.5 DATA BASE UPDATE PROCESS (FUNCTION 5)

As shown in Figures 5-6 through 5-8, the PATCO data base update process is similar to the process used with the WMATA programs. Like the WMATA process, control of the data sets is shared by the supervisors. Nonsupervisory staff who have access to the data sets have been instructed not to update the data.

## 5.6 ADDITIONAL REQUIREMENTS

Because of the experience at WMATA in getting controller/dispatchers to identify additional requirements, these requirements were solicited from the very start of training at PATCO, using as examples the items that the WMATA controller/dispatchers had identified three months earlier. The list of PATCO-specific requirements and the results of a September 1983 supervisory review are given below (some of the suggested requirements were not supported by all controllers).

1. Emergency checklist procedures, i.e., derailment, bomb scare, third rail trippings, suicides.
2. Car equipment troubleshooting procedures checklist.
3. Car equipment modification and breakdown history.
4. Conrail-shared corridor - milepost and phone number.
5. Philadelphia station lighting cables; New Jersey station lighting.
6. Pertinent station information (CFA system, fare collection).
7. PAX line phone numbers in stations (note: this has already been done).
8. List of all company PAX phones and locations.
9. Emergency call up list similar to the one in the procedure book.
10. Emergency schedule headway optimization under emergency conditions.
11. Key employee telephone numbers for emergencies, or telephone numbers of all employees.
12. Fire extinguisher location and type for all facilities.
13. Complete dispatcher's procedure book entered on computer data base.
14. Station identification by number similar to fare collection identification - referenced by milepost (possibly in fare collection system).
15. Run time in reverse operation between interlockings to establish best headway pattern (including departure times resulting in the best "meets" during emergency situations where a section of track is out of service).



16. Emergency ladder locations.
17. Third rail - which side of the track?
18. Wayside equipment out of service - interlockings, switches, power controls.
19. Location of third rail heaters.
20. Dispatchers' capability to control yard power.
21. Location of hospitals in proximity to stations.
22. Track circuits by milepost (and length of track circuit in feet).

In the September 1983 supervisory review of the requirements, one reviewer provided the following outline:

- I. Emergencies (Items 1, 4, 6, 7, 8, 9, 11, 12, 16, 17, 18, 21)
  - A. Procedural Checklist
  - B. Station Information (Graphics) including exits, stairways, and escalators
  - C. Call List
- II. Restoration of Services (Items 2,3,10,15)
- III. Housekeeping (Word Processing Capability) such as maintenance log (carry over), so dispatcher is not burdened with redundant functions

## 5.7 SUMMARY

The PATCO AERS demonstration system is closer to an operational system than the WMATA version. In fact, it required only a few additional programs and data points to become an extremely useful tool for the controller/dispatchers.



# PATCO INFORMATION RETRIEVAL SYSTEM

## FUNCTIONS:

- 1 GET DATA ON A LOCATION
  - 2 DISPLAY DATA BASE ENTRIES
  - 5 MISCELLANEOUS PROGRAMS
  - P PRINT CURRENT SCREEN DISPLAY
- RETURN RETURN TO THIS MENU

ENTER ---> <RETURN>, 1-5, P

FIGURE 5-1. PATCO DEMONSTRATION AERS, MAIN MENU

MILEPOST 5.5 IS:

1.73 MILES FROM BROADWAY  
0.33 MILES FROM FERRY AVE.

ACCESS: 5.46: 8' EMER GATE-WB-BETW WHI  
TMAN AV & COPEWOOD ST ON  
THORNDYKE-W OF PEDESTRI  
AN UNDERPASS

5.77: 4' EMER GATE-EB-BETW COP  
EWOOD & FERRY AV ON ACCE  
SS RD-360' W OF FERRY AV  
STA

STREETS: 5.27: C/L UG WHITMAN AVE  
5.69: C/L UG COPEWOOD ST

ENTER ---> <RETURN>, 1-5, P

FIGURE 5-3. DISPLAY DATA ON A LOCATION (FUNCTION 1), SECOND SCREEN

MILEPOST 5.5 IS:

1.73 MILES FROM BROADWAY  
0.33 MILES FROM FERRY AVE.

AREA: GRADE - FILL

3RD RAIL: TK-1: SECT5-33010 33; 33010 34

TK-2: SECT5-3302 033; 3302 034

F/D TO CALL: CAMDEN 911; POL 911; COUNTY  
{0}-POL {227}

<SPACE> MORE, <RETURN>, 1-5, P

FIGURE 5-2. DISPLAY DATA ON A LOCATION (FUNCTION 1), FIRST SCREEN

# THIRD RAIL-TK 2

0 - 25 SECT1-2902 030  
.25 - .99 SECT2-3002 030; BROAD NO2<  
0.99 SEPTA 2902-3002> 030; N22  
99 - 1.19 SECT3-M22 0.99; 3102 031;  
EM22 01.19; RECLOSE 3102 0  
1.19 - 2.41 SECT3A-M22 0.99; 3102 031;  
EM22 01.19; CHECK S22 OPE  
N22 41; RECLOSE M22 0.99;  
THIS ALSO DEENERGIZES TAI  
LTK 0 MKT.  
2.41 - 3 SECT4-MAKE CERTAIN CY1 OR  
CY2 OPEN; 3202 032; 3202 0  
33; CHECK S22 02.41; 322W  
033; 38; RECLOSE 3202 033  
3 - 3.38 SECT12-CAMDEN YD-CY1&CY2 0  
32  
3.38 - 4 SECT14A-3202 032; 3202 033;  
CHECK S22 02.41; 322W 03  
38; RECLOSE 3202 032  
<SPACE> MORE, <RETURN>, 1-5, P

FIGURE 5-4. PATCO DEMONSTRATION AERS, DISPLAY DATA BASE ENTRIES (FUNCTION 2) FOR THIRD RAIL, TRACK NO. 2

```

INTERLOCKINGS
09 12 LOCUST CIRC 2901 2902 SUB 3
53 0 SUPRU CONTR CIRC 3001 3002 SUB
1.19 30 31 SUPU CONTR LOCUST 3001 3002 SUB
3.18 1 39 MARKET-CIRC 3001 3002 SUB
3.37 30 31 SUPU CONTR AREA CIRC 3101 31
3.77 02-SUB 32-SUPU CONTR BROADWAY
5.71 3 41 HALL-CIRC 3201 3202-SUB 32
7.92 33-SUPU CONTR BROADWAY
10.5 33-SUPU CONTR BROADWAY
11.54 33-SUPU CONTR BROADWAY
SPACE> MORE, <RETURN>, 1-5, P

```

FIGURE 5-5. PATCO DEMONSTRATION AERS, DISPLAY  
DATA BASE ENTRIES (FUNCTION 2)  
FOR INTERLOCKINGS

```

*****
PATCO DATA BASE UPDATE PROGRAM
*****
FILES AVAILABLE:
1. TYPE OF AREA
2. ACCESSES
3. STREETS
4. FIRE DEPTS
5. INTERLOCKINGS
6. THIRD RAIL-TK 1
7. THIRD RAIL-TK 2
8. PHONES
9. NJ HIGH VOLTAGE PROGRAM <<<
0. >>> TERMINATE PROGRAM <<<
SELECT A NUMBER (0THRU9):

```

FIGURE 5-6. PATCO DATA BASE UPDATE PROGRAM  
(FUNCTION 5), FIRST SCREEN

```

DO YOU WANT TO SEARCH BY:
1. MILEPOST
2. ITEM
INPUT '1' OR '2' :
TYPE OF AREA

```

FIGURE 5-7. PATCO DATA BASE UPDATE  
(FUNCTION 5) SEARCH ROUTINE

```

WHAT IS THE NAME OF THE ITEM YOU WANT?
HINT: TO INCREASE THE CHANCE OF FINDING
THE PROPER LOCATION, INPUT THE FEWEST
NUMBER OF CHARACTERS WHICH WILL DEFINE
THIS AREA.
ITEM: AER
1.67 AERIAL - END OF BRIDGE
2.67 AERIAL (VIADUCT)
7.11 AERIAL (VIADUCT)
8.26
WHAT IS THE MILEPOST OF THE ITEM YOU
WISH TO REVISE?
TYPE OF AREA

```

FIGURE 5-8. PATCO DATA BASE UPDATE  
(FUNCTION 5) SEARCH ROUTINE FOR  
AN ITEM: TEST RETRIEVAL

## 6. CURRENT STATUS OF THE DEMONSTRATION AERS

The challenge for WMATA and PATCO control room staff was to expand their respective AERS data bases with a minimum of TSC, BART and UMTA support. Their equipment base was not extensive. Each transit system was supplied with one microprocessor, disk drive, video monitor, printer, etc., and no backup or developmental equipment. Their programming and programming support bases were also minimal. Each transit system was provided with limited training in the AERS software but no training in Applesoft BASIC, the fundamental programming language of the APPLE II Plus microprocessor.

The transit systems were given Apple manuals and advice on how to program. The only additional programming support was limited software support with which to troubleshoot problems. Neither transit system was provided with professional programming support.

This section describes the activities of the central control staff, since the installation of the demonstration, to extend the software to meet their organizations' requirements. In general, each system's software was extended far beyond what members of the installation team had initially thought possible. Given that the demonstration software was not well documented and used advanced programming techniques for cursor control, the achievements of both the WMATA and PATCO central control staff were especially noteworthy.

### 6.1 WMATA

When the deployment team left in December 1982, WMATA AERS had data for only one line, the C-line from Metro to National Airport, and the staff was adding data for the K-line from Rosslyn to Ballston. Since then, data has been added for the A-line (Metro to Van Ness); B-line (Metro to Silver Spring); D-line (Metro to New Carrollton); and G-line (Metro to Addison Road). In addition, more detailed descriptions have been added to a number of the data points. As of September 1983, the only line in service without data in the data files is the L-line (L'Enfant Plaza to Pentagon).



At the time of the deployment team's departure, no member of the central control staff had been trained in BASIC. Since then, one of the assistant superintendents has obtained formal training at his own expense for programming in BASIC, and another assistant superintendent has essentially trained himself to program in BASIC by using Apple manuals and other published sources.

WMATA has also added a checklist and a system map to its software. The latter is important because it is a first step towards a graphics capability, a function which supervisors and controller/dispatchers have sought. (See Figure 6-1 on page 44 for the screen of the system map. All of the figures appear at the end of this section, on pages 44-49.)

The checklist added by WMATA central control (Figure 6-2) is another item of importance to WMATA supervisors and controller/dispatchers, for two reasons. First, it formalizes the incident reporting process by providing printed formatted output for supervisor and controller/dispatcher notes. Second, it provides a readily available reference document that summarizes the system's formal standard operating procedures. Figures 6-3 through 6-6 show different operating procedures which have been programmed to date.

The WMATA staff has begun to add elements of the power distribution system to the AERS system and track graphics (see Figures 6-7 and 6-8). The transit system has also begun to extensively revise the ventilation schema that was incorporated in the original demonstration software. For the first time, the actual program design and coding is being performed by personnel other than the central control staff (in this instance, by the safety staff).

## 6.2 PATCO

Because PATCO operates only one line, and because its data base was fairly complete when the installation team left in February 1983, PATCO began to: (1) provide formal and informal training for the staff; (2) revise data terminology to reflect the way Center Tower controller/dispatchers actually communicate with other PATCO personnel; and (3) add further capabilities.

The data base revisions and added capacities are especially interesting because PATCO extended the software and data bases seemingly with "other-than-prime-time" shifts in mind. Some of these shifts are covered by only one employee (backed up by PATCO supervisory staff on an "on call" basis), who may often be



a "part-timer" working a second job. PATCO central control supervisors have had to report in for those shifts to assist during abnormal operations. It appears that these software and data base revisions and additions were specifically designed to reduce the number of times that the supervisory staff has to report to work during these weekend periods.

PATCO has added more descriptions to the data sets for safety department (fire and police) jurisdictions. Two backup phone numbers have been coded for the police and fire departments to expedite communications in an emergency, as shown in Figure 6-9. PATCO has also enlarged descriptions in the data sets for third rails, interlockings, and single tracking (see Figure 6-10). In changing these descriptions, PATCO has expanded the display for retrieving data on a location to four screens (see Figures 6-11 through 6-14). PATCO has also added a module for high voltage circuits, and the main menu has been revised accordingly, as shown in Figures 6-15 through 6-17.

PATCO management has taken a visible role in encouraging its system's AERS development - for example, by encouraging both formal and informal training. At PATCO's expense, two controller/dispatchers have taken introductory and BASIC programming language courses at local colleges.

### 6.3 FUTURE DIRECTIONS

The WMATA control room staff has been identifying the location of gaps in the third rails and entering this data into the program. As mentioned before, a new ventilation schema to replace the ventilation programs installed in December 1982 is being programmed. PATCO has been specifying the programming needed for a scheduling module to assist in the train-scheduling function of central control.

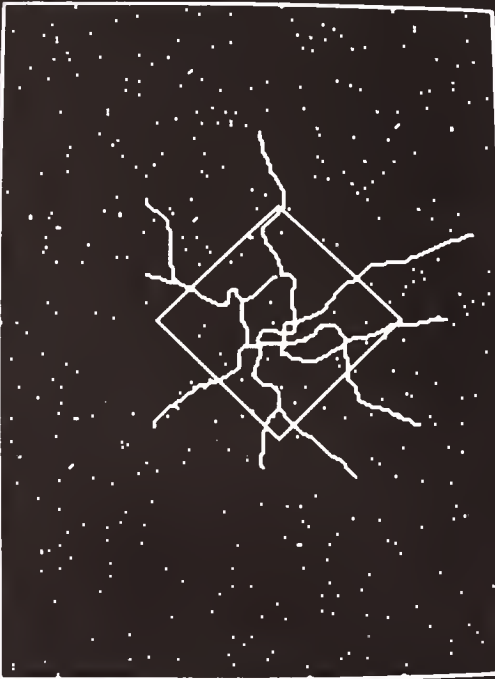


FIGURE 6-1. WMATA SYSTEM MAP

WMATA  
EMERGENCY INFORMATIONAL CHECKLIST

1. FIRE - TRAIN \* STATION \* RIGHT-OF-WAY
2. MAINLINE DERAILMENT / COLLISION
3. PERSON HIT BY TRAIN
4. PASSENGER EVACUATION
5. EMERGENCY ON THE COMMON CORRIDOR
6. BOMB THREAT - TRAIN / STATION
7. FLAMMABLE VAPOR ALARM
8. STORM AND SNOW OPERATIONS
9. FLOODS

PICK 1-9, R FOR MAIN MENU, P FOR PRINT

FIGURE 6-2. WMATA EMERGENCY PROCEDURES CHECKLIST, MAIN MENU

# TYPE OF FIRE

1. FIRE ON TRAIN
2. FIRE IN STATION
3. FIRE ON RIGHT-OF-WAY

PRESS DESIRED NUMBER

FIGURE 6-3. WMATA EMERGENCY PROCEDURES CHECKLIST, FIRST OPTION

FIRE ON TRAIN SOP #7

- ( ) GET THE EXACT LOCATION OF TRAIN
- ( ) UNLOAD PASSENGERS IF IN STATION
- ( ) STOP ALL APPROACHING TRAINS
- ( ) NOTIFY AREA FIRE DEPT. IF NEEDED
- ( ) NOTIFY TRANSIT POLICE - CALL SHEET
- ( ) DISPATCH TRANSPORTATION SUPERVISOR
- ( ) REMOVE THIRD RAIL POWER IF NECESSARY
- ( ) UPDATE FIRE DEPARTMENT
- ( ) PREPARE FOR EVACUATION

PRESS ANY KEY FOR MAIN MENU P FOR PRINT

FIGURE 6-4. WMATA EMERGENCY PROCEDURES CHECKLIST, TRAIN FIRE OPTION

# FIRE IN STATION SOP #8

- ( ) ASCERTAIN THE EXACT LOCATION OF FIRE
- ( ) EVACUATE AND CLOSE STATION
- ( ) STOP ALL APPROACHING TRAINS
- ( ) NOTIFY AREA FIRE DEPARTMENT
- ( ) NOTIFY TRANSIT POLICE - CALL SHEET
- ( ) DISPATCH TRANSPORTATION SUPERVISOR
- ( ) REMOVE THIRD RAIL POWER IF NECESSARY

PRESS ANY KEY FOR MAIN MENU P FOR PRINT

FIGURE 6-5. WMATA EMERGENCY PROCEDURES CHECKLIST, STATION FIRE OPTION

# STORM AND SNOW OPERATIONS SOP #21

- ( ) NOTIFY GENERAL SUPERINTENDENT
- ( ) ISSUE A 'STORM ALERT'
- ( ) INITIATE EMERGENCY CALL SHEET

PRESS ANY KEY FOR MAIN MENU P FOR PRINT

FIGURE 6-6. WMATA EMERGENCY PROCEDURES CHECKLIST, STORM AND SNOW OPTION

# WMATA TRACTION POWER GAPS

\*\*\*\*\*

- |                |                 |
|----------------|-----------------|
| 1.A--(A15-A09) | 7.D--(D01-D09)  |
| 2.A--(A08-A01) | 8.D--(D08-D13)  |
| 3.B--(B01-B08) | 9.F--(F01-F09)  |
| 4.B--(B07-B11) | 10.G--(G01-G03) |
| 5.C--(C01-C09) | 11.K--(K01-K10) |
| 6.C--(C08-C15) |                 |

PRESS DESIRED NUMBER

?1

FIGURE 6-7. WMATA TRACTION POWER GAPS MENU

AB C D F G



1 2 3 4 5 6 7 8 9 0



FIGURE 6-8. WMATA INTERLOCKINGS GRAPHICS



# FIRE DEPT

0 PHILA 911 POLICE 911  
 1.67 DRPA(1.67-3.16)HOT LINE, POL HOT  
 2.41 LINE  
 CAMDEN COUNTY LINE 0 (227) IF BU  
 SY 757-7500  
 6.03 NY-227 IF BUSY, CALL 911 POLICE-CO  
 COLLINGSWOOD 854-1115; POL 854-1  
 900; COUNTY (0/246)-POL (362)  
 7.87 HADDON TWP 854-1234; POL 854-00  
 11; COUNTY-(0/244)-POL (346)  
 8.78 HADDONFIELD 429-2400; POL 429-30  
 00; COUNTY-(0/243)-POL (294)  
 11.25 CHERRY HILL 662-1111; POL 665-12  
 00; COUNTY-(0/241)-POL (342)  
 12.54 VOORHEES TWP 783-4444; POL 428-  
 5400; COUNTY-(0/328)-POL (345)  
 14.07 SOMERDALE S.SIDE 783-4444; POL 7  
 83-4900; COUNTY-(0/322)-POL (355)  
 14.2 F BUSY 783-4444 POLICE 784-4800  
 ENTER ----> (353)  
 <RETURN>, 1-6, P

FIGURE 6-9. PATCO FIRE EMERGENCY DATA SET

# MILEPOST 5.5 IS

1.73 MILES FROM BROADWAY  
 0.33 MILES FROM FERRY AVE

IF THIRD RAIL POWER IS NOT INVOLVED,  
 THEN SINGLE TRACK BETWEEN

# NEW AND FERRY

<SPACE> MORE, <RETURN>, 1-6, P

FIGURE 6-11. RETRIEVAL OF PATCO DATA ON LOCATION, FIRST OF FOUR SCREENS

# THIRD RAIL-TK 1

0 - 28 2901 CIRCUIT <END OF TRACK  
 TO L011> TO DEENERGIZE,  
 OPEN 2901 AT SUB #30  
 BEST HEADW  
 AY 7 5 MINUTES <LOCUST-11T  
 H> NOTES--NO TURNING IN #  
 1 TAIL TRACK & LOSS OF  
 COMPRESSORS OF A STORED TR  
 AIN  
 .28 - 99 3001 CIRCUIT <L011-M11> TO  
 DEENERGIZE, 1 AT SANSOM &  
 SUB 30 & M11 "BROAD #1"  
 CHECK OPEN 10 MINUTES  
 BEST HEADWAY IS 10 MINUTES  
 <LOCUST-MARKET> SINGLE TR  
 ACK ON #2  
 .99 - 1.19 1 & CHECK OPEN S11, CLOSE  
 EM11 & CLOSE THE3001 & 310  
 1 @ MINUTES <11TH-MARKET>  
 <SPACE> MORE, <RETURN>, 1-6, P

FIGURE 6-10. PATCO THIRD RAIL DATA, CODING AS OF SEPTEMBER 1983

# MILEPOST 5.5 IS

1.73 MILES FROM BROADWAY  
 0.33 MILES FROM FERRY AVE

# 3RD RAIL-TK 1

3301 CIRCUIT <CT11-F11> TO DEENERGIZE--  
 OPEN 3301 @ SUBS 33 & 34 TO SECTIONALIZE--  
 MAIN ER/SUP'R MUST OPEN 331W OR 331E & IN  
 3301 CLOSED AT SUB 34 NOTE, 6-CAR TRAIN  
 CAN'T BE TURNED IF 331E IS OPENED, BEST  
 HEADWAY-20 MIN <WAY-WOOD> ON #2 TRACK

# 3RD RAIL-TK 2

3302 CIRCUIT CT22-F22 OPEN 3302 AT 33&34  
 LOSS OF FERRY TO SECTIONALIZE OPEN 332W  
 OR 332E CLOSE 3302 AT 33 OR 34 HEADWAY  
 15 MIN FERRY TO WAY WOOD

<SPACE> MORE, <RETURN>, 1-6, P

FIGURE 6-12. RETRIEVAL OF PATCO DATA ON LOCATION, SECOND OF FOUR SCREENS



MILEPOST 5.5 IS:

1.73 MILES FROM BROADWAY  
0.33 MILES FROM FERRY AVE.

WFEH GRADE - FILL

F D TO CALL CAMDEN COUNTY LINE 0 (227)  
IF BUSY 757-7500  
POLICE-COUNTY-227 IF BUSY.  
CALL 911.

ACCESS 5 46: 81 EMER GATE-WB-BETW WHI  
THAN AU & COPEWOOD ST ON  
THORNOYKE-W OF PEDESTPI  
AN UNDERPASS

ENTER MODE, <RETURN>, 1-6, P

FIGURE 6-13. RETRIEVAL OF PATCO DATA  
ON LOCATION, THIRD OF  
FOUR SCREENS

MILEPOST 5.5 IS:

1.73 MILES FROM BROADWAY  
0.33 MILES FROM FERRY AVE.

STREETS: 5.27: C/L UG WHITMAN AVE

5.69: C/L UG COPEWOOD ST

ENTER ---> <RETURN>, 1-6, P

FIGURE 6-14. RETRIEVAL OF PATCO DATA  
ON LOCATION, LAST OF  
FOUR SCREENS

ENTER THE CIRCUIT NUMBER DESIRED

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1049 1050 1051 1052 1053 1054 1055 1056 1057 1058 1059 1060 1061 1062 1063 1064 1065 1066 1067 1068 1069 1070 1071 1072 1073 1074 1075 1076 1077 1078 1079 1080 1081 1082 1083 1084 1085 1086 1087 1088 1089 1090 1091 1092 1093 1094 1095 1096 1097 1098 1099 1100 1101 1102 1103 1104 1105 1106 1107 1108 1109 1110 1111 1112 1113 1114 1115 1116 1117 1118 1119 1120 1121 1122 1123 1124 1125 1126 1127 1128 1129 1130 1131 1132 1133 1134 1135 1136 1137 1138 1139 1140 1141 1142 1143 1144 1145 1146 1147 1148 1149 1150 1151 1152 1153 1154 1155 1156 1157 1158 1159 1160 1161 1162 1163 1164 1165 1166 1167 1168 1169 1170 1171 1172 1173 1174 1175 1176 1177 1178 1179 1180 1181 1182 1183 1184 1185 1186 1187 1188 1189 1190 1191 1192 1193 1194 1195 1196 1197 1198 1199 1200 1201 1202 1203 1204 1205 1206 1207 1208 1209 1210 1211 1212 1213 1214 1215 1216 1217 1218 1219 1220 1221 1222 1223 1224 1225 1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1238 1239 1240 1241 1242 1243 1244 1245 1246 1247 1248 1249 1250 1251 1252 1253 1254 1255 1256 1257 1258 1259 1260 1261 1262 1263 1264 1265 1266 1267 1268 1269 1270 1271 1272 1273 1274 1275 1276 1277 1278 1279 1280 1281 1282 1283 1284 1285 1286 1287 1288 1289 1290 1291 1292 1293 1294 1295 1296 1297 1298 1299 1300 1301 1302 1303 1304 1305 1306 1307 1308 1309 1310 1311 1312 1313 1314 1315 1316 1317 1318 1319 1320 1321 1322 1323 1324 1325 1326 1327 1328 1329 1330 1331 1332 1333 1334 1335 1336 1337 1338 1339 1340 1341 1342 1343 1344 1345 1346 1347 1348 1349 1350 1351 1352 1353 1354 1355 1356 1357 1358 1359 1360 1361 1362 1363 1364 1365 1366 1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1384 1385 1386 1387 1388 1389 1390 1391 1392 1393 1394 1395 1396 1397 1398 1399 1400 1401 1402 1403 1404 1405 1406 1407 1408 1409 1410 1411 1412 1413 1414 1415 1416 1417 1418 1419 1420 1421 1422 1423 1424 1425 1426 1427 1428 1429 1430 1431 1432 1433 1434 1435 1436 1437 1438 1439 1440 1441 1442 1443 1444 1445 1446 1447 1448 1449 1450 1451 1452 1453 1454 1455 1456 1457 1458 1459 1460 1461 1462 1463 1464 1465 1466 1467 1468 1469 1470 1471 1472 1473 1474 1475 1476 1477 1478 1479 1480 1481 1482 1483 1484 1485 1486 1487 1488 1489 1490 1491 1492 1493 1494 1495 1496 1497 1498 1499 1500 1501 1502 1503 1504 1505 1506 1507 1508 1509 1510 1511 1512 1513 1514 1515 1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531 1532 1533 1534 1535 1536 1537 1538 1539 1540 1541 1542 1543 1544 1545 1546 1547 1548 1549 1550 1551 1552 1553 1554 1555 1556 1557 1558 1559 1560 1561 1562 1563 1564 1565 1566 1567 1568 1569 1570 1571 1572 1573 1574 1575 1576 1577 1578 1579 1580 1581 1582 1583 1584 1585 1586 1587 1588 1589 1590 1591 1592 1593 1594 1595 1596 1597 1598 1599 1600 1601 1602 1603 1604 1605 1606 1607 1608 1609 1610 1611 1612 1613 1614 1615 1616 1617 1618 1619 1620 1621 1622 1623 1624 1625 1626 1627 1628 1629 1630 1631 1632 1633 1634 1635 1636 1637 1638 1639 1640 1641 1642 1643 1644 1645 1646 1647 1648 1649 1650 1651 1652 1653 1654 1655 1656 1657 1658 1659 1660 1661 1662 1663 1664 1665 1666 1667 1668 1669 1670 1671 1672 1673 1674 1675 1676 1677 1678 1679 1680 1681 1682 1683 1684 1685 1686 1687 1688 1689 1690 1691 1692 1693 1694 1695 1696 1697 1698 1699 1700 1701 1702 1703 1704 1705 1706 1707 1708 1709 1710 1711 1712 1713 1714 1715 1716 1717 1718 1719 1720 1721 1722 1723 1724 1725 1726 1727 1728 1729 1730 1731 1732 1733 1734 1735 1736 1737 1738 1739 1740 1741 1742 1743 1744 1745 1746 1747 1748 1749 1750 1751 1752 1753 1754 1755 1756 1757 1758 1759 1760 1761 1762 1763 1764 1765 1766 1767 1768 1769 1770 1771 1772 1773 1774 1775 1776 1777 1778 1779 1780 1781 1782 1783 1784 1785 1786 1787 1788 1789 1790 1791 1792 1793 1794 1795 1796 1797 1798 1799 1800 1801 1802 1803 1804 1805 1806 1807 1808 1809 1810 1811 1812 1813 1814 1815 1816 1817 1818 1819 1820 1821 1822 1823 1824 1825 1826 1827 1828 1829 1830 1831 1832 1833 1834 1835 1836 1837 1838 1839 1840 1841 1842 1843 1844 1845 1846 1847 1848 1849 1850 1851 1852 1853 1854 1855 1856 1857 1858 1859 1860 1861 1862 1863 1864 1865 1866 1867 1868 1869 1870 1871 1872 1873 1874 1875 1876 1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1888 1889 1890 1891 1892 1893 1894 1895 1896 1897 1898 1899 1900 1901 1902 1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079 2080 2081 2082 2083 2084 2085 2086 2087 2088 2089 2090 2091 2092 2093 2094 2095 2096 2097 2098 2099 2100 2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111 2112 2113 2114 2115 2116 2117 2118 2119 2120 2121 2122 2123 2124 2125 2126 2127 2128 2129 2130 2131 2132 2133 2134 2135 2136 2137 2138 2139 2140 2141 2142 2143 2144 2145 2146 2147 2148 2149 2150 2151 2152 2153 2154 2155 2156 2157 2158 2159 2160 2161 2162 2163 2164 2165 2166 2167 2168 2169 2170 2171 2172 2173 2174 2175 2176 2177 2178 2179 2180 2181 2182 2183 2184 2185 2186 2187 2188 2189 2190 2191 2192 2193 2194 2195 2196 2197 2198 2199 2200 2201 2202 2203 2204 2205 2206 2207 2208 2209 2210 2211 2212 2213 2214 2215 2216 2217 2218 2219 2220 2221 2222 2223 2224 2225 2226 2227 2228 2229 2230 2231 2232 2233 2234 2235 2236 2237 2238 2239 2240 2241 2242 2243 2244 2245 2246 2247 2248 2249 2250 2251 2252 2253 2254 2255 2256 2257 2258 2259 2260 2261 2262 2263 2264 2265 2266 2267 2268 2269 2270 2271 2272 2273 2274 2275 2276 2277 2278 2279 2280 2281 2282 2283 2284 2285 2286 2287 2288 2289 2290 2291 2292 2293 2294 2295 2296 2297 2298 2299 2300 2301 2302 2303 2304 2305 2306 2307 2308 2309 2310 2311 2312 2313 2314 2315 2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330 2331 2332 2333 2334 2335 2336 2337 2338 2339 2340 2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353 2354 2355 2356 2357 2358 2359 2360 2361 2362 2363 2364 2365 2366 2367 2368 2369 2370 2371 2372 2373 2374 2375 2376 2377 2378 2379 2380 2381 2382 2383 2384 2385 2386 2387 2388 2389 2390 2391 2392 2393 2394 2395 2396 2397 2398 2399 2400 2401 2402 2403 2404 2405 2406 2407 2408 2409 2410 2411 2412 2413 2414 2415 2416 2417 2418 2419 2420 2421 2422 2423 2424 2425 2426 2427 2428 2429 2430 2431 2432 2433 2434 2435 2436 2437 2438 2439 2440 2441 2442 2443 2444 2445 2446 2447 2448 2449 2450 2451 2452 2453 2454 2455 2456 2457 2458 2459 2460 2461 2462 2463 2464 2465 2466 2467 2468 2469 2470 2471 2472 2473 2474 2475 2476 2477 2478 2479 2480 2481 2482 2483 2484 2485 2486 2487 2488 2489 2490 2491 2492 2493 2494 2495 2496 2497 2498 2499 2500 2501 2502 2503 2504 2505 2506 2507 2508 2509 2510 2511 2512 2513 2514 2515 2516 2517 2518 2519 2520 2521 2522 2523 2524 2525 2526 2527 2528 2529 2530 2531 2532 2533 2534 2535 2536 2537 2538 2539 2540 2

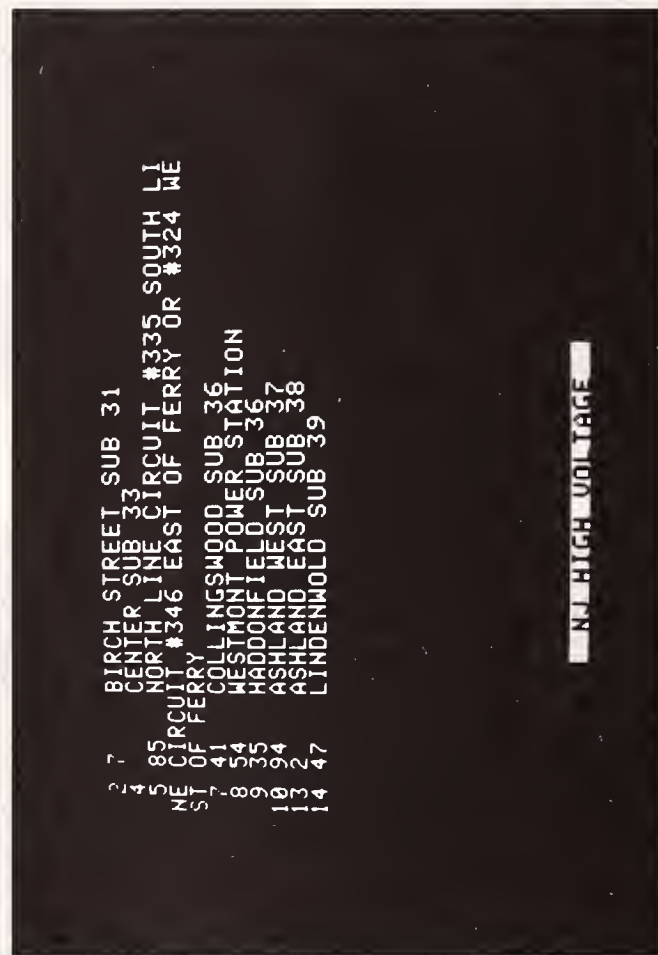


FIGURE 6-17. PATCO NEW JERSEY HIGH-VOLTAGE  
CIRCUIT GRID

## 7. DEVELOPMENT OF A GENERALIZED, GENERIC SYSTEM

The initial BART AERS and the WMATA and PATCO deployment efforts have demonstrated that an AERS can considerably enhance a transit system's ability to respond to an emergency situation in a timely and effective manner. Additional site demonstrations at other transit systems have generated considerable interest in the transit community, and several transit systems have requested UMTA assistance in obtaining their own AERS. In answer to these requests, UMTA has asked that TSC undertake the development of a generic AERS (AERS II). In identifying desirable system attributes, it was determined that the generic AERS should:

1. Be fast and accurate.
2. Have sufficient storage capability to accommodate data sets for the largest system.
3. Be easy to transport to and install at a new transit system.
4. Be easy to modify to meet a system's unique requirements by the addition of video monitor screens, the alteration of existing screens, etc.
5. Be easy for central control staff who are not computer professionals to program.
6. Allow the required data sets to be built with a minimum of effort, either by entering data or downloading data from the transit system's mainframes.
7. Be virtually self-documenting.
8. Be modular, so that when new modules are developed by specific transit systems, they can be easily transported and added to another system's AERS.

To develop a generic system meeting these requirements, TSC proposed the project implementation plan shown in Figure 7-1. This plan consists of the following ten tasks:

Task 1     AERS II system design description

Task 2     AERS II data, emergency response and related specifications



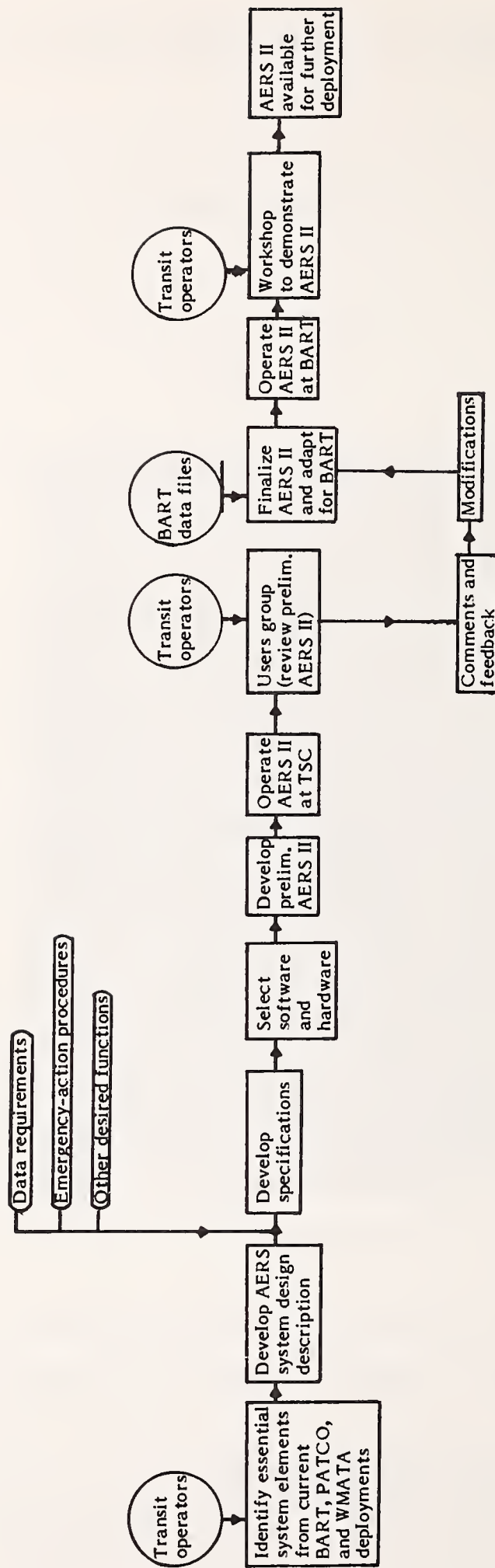


FIGURE 7-1. AERS II DEVELOPMENT PLAN

- Task 3     Formation of a user group
- Task 4     Enlistment of BART technical support
- Task 5     Development and refinement of AERS II program(s)
- Task 6     User group meeting
- Task 7     Application of AERS II to BART
- Task 8     AERS II documentation
- Task 9     AERS II demonstration/workshop
- Task 10    AERS II distribution and support

These tasks make use of the expertise of the transit community and the experience gained in the original BART AERS and subsequent WMATA and PATCO AERS deployment efforts.

The functional goals and objectives outlined in Table 7-1, the system-oriented goals and objectives outlined in Table 7-2, and the schema for AERS II (an 8, 16 or 32-bit microprocessor-based system) shown in Figure 7-2 are the results of Task 1. The results of Task 2 are shown in the Data Specification List presented in Tables 7-3 and 7-4. The specific emergency procedures requirements identified by WMATA and PATCO (discussed in sections 4.6 and 5.6 of this report) supplement the material in Table 7-4. The next task to be performed is the formation of a user group to assist in formulating the final AERS program design, and to help in its development.

The AERS effort has been a joint government and industry venture. As can be seen by the inclusion of BART technical support and an industry user group in the implementation plan, this policy of government-industry cooperation will continue to play a major role in the design and development of the generic AERS II. This new, highly adaptable AERS, to be based on the experiences described in this report, will have a significant impact on the emergency response capability of user transit systems, with the potential for wider transit applications as well.

TABLE 7-1. FUNCTIONAL GOALS AND OBJECTIVES

- o CONTAIN ALL NECESSARY EMERGENCY INFORMATION
- o BE EASILY TRANSPORTABLE FROM ONE TRANSIT SYSTEM TO ANOTHER, PRINCIPALLY BY ADDING THE DATA FOR THE NEW SYSTEM
- o MAKE IT SIMPLE FOR THE TRANSIT SYSTEM TO IMPLEMENT CHANGES IN SCREEN FORMAT AND INFORMATION
- o BE IMMEDIATELY USABLE BY A TRANSIT SYSTEM (i.e., TURNKEY DELIVERY)
- o BE EASILY LEARNED BY PEOPLE WITHOUT COMPUTER BACKGROUND
- o ALLOW FOR IMPROVEMENT BY PEOPLE WITHOUT COMPUTER BACKGROUND
- o BE USER FRIENDLY AND PROVIDE AID TO USERS IN CORRECTING SYNTAX AND OTHER USAGE ERRORS
- o HAVE SELF-DOCUMENTING PROGRAMS, WITH MINIMAL NEED FOR A MANUAL
- o RESPOND RAPIDLY, ESPECIALLY IN EMERGENCY MODE
- o ALLOW FOR EASY UPDATING OF INPUT FILES
- o STAND ALONE, WITH NO RELIANCE ON OTHER COMPUTERS
- o BE ALWAYS AVAILABLE (AND THEREFORE BE EXTREMELY RELIABLE)
- o ALLOW USERS TO MAKE SIMPLE MODIFICATIONS OF EMERGENCY AND OTHER PROCEDURES
- o PROVIDE FOR SECURITY OF SOFTWARE AND DATA FILES FROM UNAUTHORIZED CHANGES

TABLE 7-2. SYSTEM-ORIENTED GOALS AND OBJECTIVES

- o SYSTEM
  - STAND ALONE MICROCOMPUTER SYSTEM
  - RAPID RESPONSE TIME
  - NOT HARDWARE SPECIFIC
  - EASY OPERATOR INTERFACE
  - EASILY LEARNED OPERATING SOFTWARE
- o HARDWARE
  - NOT RESTRICTED TO ONE BRAND
  - SMALL SIZE (MINIMIZE SPACE REQUIREMENTS)
  - WIDE RANGE OF MASS STORAGE DEVICES TO ALLOW MATCHING NEEDS OF INDIVIDUAL TRANSIT PROPERTIES
  - NO SPECIAL ENVIRONMENT REQUIREMENTS
  - NO SPECIAL POWER REQUIREMENTS
- o SOFTWARE
  - MODULAR CONCEPT
  - PORTABLE PROGRAMMING LANGUAGE
  - EASILY PROGRAMMED INPUT AND OUTPUT VIDEO MONITOR SCREENS
  - MAIN MENU SCREENS WITH SELF CHECKING ENTRIES TO MINIMIZE ERRORS
  - BOTH GRAPHICAL AND TABULAR DATA ENTRY
  - COMPLETE USER DOCUMENTATION FOR OPERATION AND DATA MAINTENANCE



# SYSTEM DESIGN DIAGRAM

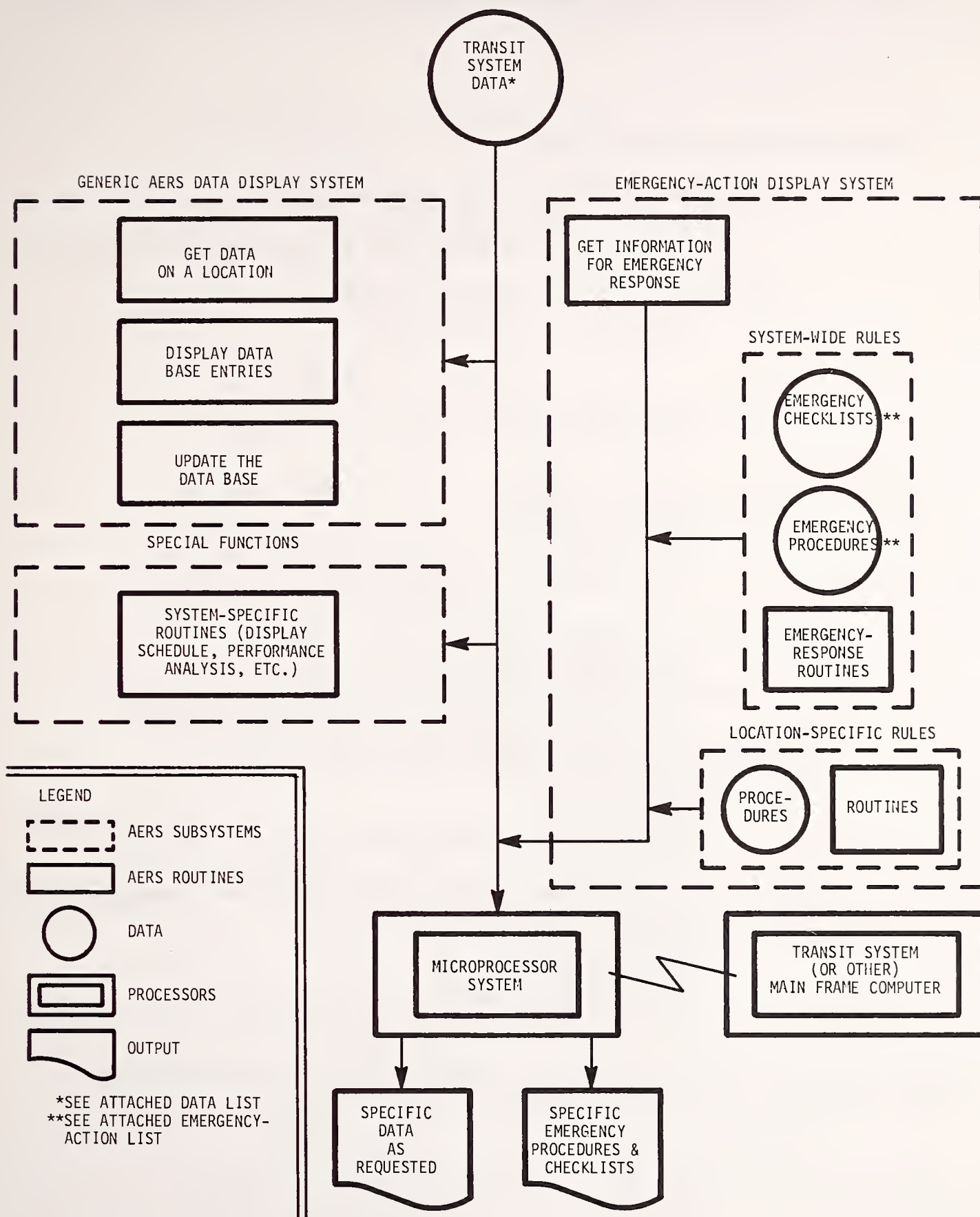


FIGURE 7-2. GENERALIZED AERS II

TABLE 7-3. DATA SPECIFICATION LIST (BASED ON FILES IN BART, PATCO  
AND WMATA AERS)

I. Emergency facilities and procedures

- A. Ventilation procedures (where appropriate)
  - Location of fans, vent shafts
  - Procedure to determine which fans to set and proper direction
- B. Evacuation procedures (where appropriate)
  - Direction in which to evacuate
  - Exit point
- C. Rescue procedures
  - Designation of rescue train
  - Exit point
- D. Fire departments to call
  - Name of department
  - Phone number
  - Portion of system covered by each fire department
- E. Police departments to call
  - Name of department
  - Phone number
  - Portion of system covered by each police department
- F. Hospitals and other medical units to call
  - Name of unit
  - Phone number
  - Portion of system covered by each unit
- G. Key transit personnel to call (security, operations, management, etc.)
  - Names
  - Positions
  - Phone numbers
  - Events for which they should be called

II. Physical system description (all items include location, shown by line, mileage  
marker, chain marker, or other descriptor)

- A. Type of area
  - Subway
  - At grade
  - Aerial
- B. Stations
  - Location of platform egresses
  - Location of mezzanine egresses

TABLE 7-3. DATA SPECIFICATION LIST (CONTINUED)

- C. Access points to system, such as
  - Stairway
  - Shaft
  - Gate
  - Grade crossing
  - Maintenance of way
  - Bridge
  - Walkway
- D. Streets
  - Name of cross street(s)
- E. People (passenger or personnel) crossovers
- F. Rail crossovers (interlockings)
- G. Third rail sections
  - Section descriptions
- H. Shared rail corridors
  - Name of co-occupant
  - Location identifiers of co-occupants
  - Controller phone number for co-occupant
- J. Other entities (such as high-voltage circuits)

### III. Communications

- A. Station phones
  - Station
  - Phone number (primary)
  - Phone number (alternate)
- B. Emergency phones on right-of-way
  - Location
  - Phone number

### IV. Anomalies (temporary changes from usual situation)

- Equipment out of order
- Equipment down for maintenance
- Special temporary rules
- New equipment

Note: The transit system should provide as complete a set of data as possible, correlated to their location code (i.e., line-and-mileage marker, line-and-chain marker, line-and-station, etc.)



## TABLE 7-4. EMERGENCY ACTION SPECIFICATION LIST

Procedure/checklist specification is by one or both of the following:

By type of response:

- Ventilation
- Evacuation
- Rescue
- Provision of alternative transit service

By type of emergency:

- Fire in tunnel
- Fire at grade or aerial
- Derailment
- Collision
- Disabled train
- Disabled operator
- Loss of power
- Critically-ill passenger
- Crime
- Bomb threat
- Toxic fumes
- Flood
- Structural or track defect found
- Suicide or other person hit
- Object on track
- Storm/snow

- Note:
- (1) The transit system should provide as complete a set of procedures as possible, correlated to their location code, i.e., line-and-mileage marker, line-and-chain marker, line-and-station, etc.
  - (2) Special output screens will be programmed to outline the procedures or checklists.

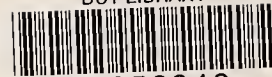
HE 18.5 .A37 no  
MTA- 84-27  
Petrie, Joseph

Development of  
Emergency Respo

~~EST~~ Library

Form DOT F 1720.2 (8-70)  
FORMERLY FORM DOT F 1700.11.1

DOT LIBRARY



00353046